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July 28, 1927

JUL 30 1927

Engineering News-Record

Gooseneck Creek
Being Confined in New Sewer
Draining Northeast Kansas City

In this issue:

The second article on highway maintenance; extended report on the International Chamber of Commerce Stockholm meeting; descriptions of the construction of Kansas City's new sewer and of a combined railway bridge and dam in Newfoundland

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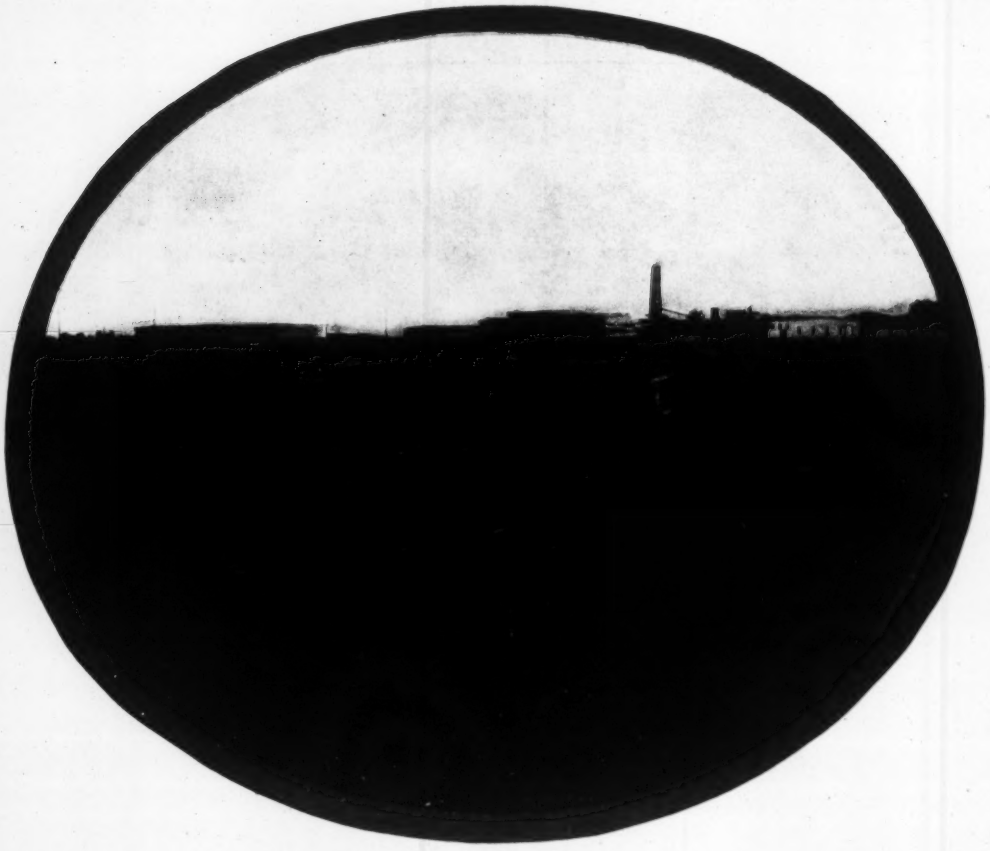

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

McGraw-Hill Publishing Co., Inc.
JAMES H. McGRAW, *President*
E. J. MEHREN, *Vice-President*

FRANK C. WIGHT
Editor

Volume 99 NEW YORK, JULY 28, 1927 Number 4

A Chapter of History

IN SPITE of the old rule that excepts presidential addresses before engineering societies from discussion, we venture to call attention to the presidential address of John F. Stevens before the American Society of Civil Engineers at Denver, on the theme "The Panama Canal," as a remarkable document, one that every civil engineer should include in his education and his library. It is an essay so far out of the ordinary, and in many respects so appropriate to the conditions of today, as to make it a fascinating piece of reading. The chapter of history Mr. Stevens has written is entitled to a permanent place in historical records. Dealing with one of the great episodes of the world's constructive enterprise—the inception and construction of the Isthmian canal—it involves human welfare, and basic relations between the peoples of the world as well as vast difficulties of both technical and administrative kind. While this is sufficient to give the story strength, we would like to refer also to its deeply instructional value, particularly to the younger engineer. It carries a flavor of old-time thought, less frequently remarked in these hurrying days, and brings its reader to a more thorough understanding of the meaning of character and determination, and the principle that the job's the thing. Moreover, it bears closely on matters of current present discussion, the feared inadequacy of the Panama Canal and the desirability of building another Isthmian canal. The authoritative statements of fact given by Mr. Stevens justify the comments on the Nicaragua canal movement recently made in these pages (Apr. 21, p. 635), to the effect that the present canal is very far indeed from approaching its service capacity, and that when larger capacity is needed it will be easier to enlarge the present canal than to build a new one in Nicaragua. It is always agreeable to have one's opinions confirmed, but doubly so to have them confirmed by an engineer and American of the type of Mr. Stevens.

Road Construction Futures

STATE systems of highways now totaling 287,928 miles are 66 per cent initially improved. This means that 66 miles out of each 100 miles of state highway have been surfaced or graded and drained for surfacing, according to engineering standards. To be specific, 163,059 miles are surfaced and 28,456 miles are ready for surfacing. The figures are worth considering in contemplating the field for future highway construction. In brief, 34 miles of every 100 miles of state roads call for full improvement; i.e., grading, draining and surfacing. Approximately 10 miles more in every 100 miles remain to be surfaced. Of the 56 miles in every 100 miles which are surfaced, the improvement grades all the way from traffic-bound top soil and gravel to the highest types of rigid pavement. The division as recorded in our business news section this week deserves attention. Only a little over a third of the mileage of surfaced road has a surface of the quality of bituminous macadam or better. Of this third (53,947 miles), almost two-thirds, or 31,935 miles, are portland cement concrete. Assuming that traffic will ultimately demand of all state system highways something better than a traffic-bound or water-bound surfacing, there exists something over 100,000 miles of the present surfaced road to be further improved. The construction work which has then to be done on state system highways is greater in amount than all that has been done without including natural renewal, reconstruction and widening or future mileage additions to systems. And there remain the county systems and other local government road operations. Indeed, it requires a far look ahead to see the time when our road improvement work will cease to be a large business for the constructor, even within the limitations of present state system mileages, and they are only 10 per cent of all road mileages. Road construction offers a good investment in futures.

May Point with Pride

CALIFORNIA may well point with pride to its low typhoid record for 1926. For the whole state the death rate per 100,000 was only 2.86. No deaths were recorded in 36 of the 58 counties nor in 28 incorporated cities. The record is all the more remarkable because, as the state board of health says, California depends "largely upon surface streams for its public water supplies." With a typhoid death rate under 3 per 100,000 modes of typhoid infection other than water supply must also be under good control.

Value of Safe Travel

FIVE years ago the Interstate Commerce Commission dropped a bomb into the railroad camp in the form of an order to each of 49 roads to install automatic train control on one full operating division. The railroads protested vigorously. They were poor; train control devices were mostly in the development stage; time was needed to experiment with test sections. The Commerce Commission listened, unconvinced. In less than two years it issued a second order doubling the number of divisions to be equipped. Meanwhile, increased prosperity had come to the railroads, and with the prosperity came increased inclination to accede to the wishes of the commission. Also, a succession of fatal accidents which might have been prevented by automatic train control focused public attention upon the matter and spurred the railroads to greater activity. The intervening years since the first order was issued have seen a great change in the attitude of the railroads toward train control, a change which is indicated by the recent announcement by the New York Central Railroad Co. that in addition to the divisions covered by the commission's orders it now has let contracts for the complete equipment of its main

line between New York City and Chicago with automatic train control. Its line from Boston to Albany already is so equipped as is part of the main line beyond Albany, but over 600 miles of the line are not yet so protected. When this latest contract is completed the New York Central not only will have added to the safety of travel over the major portion of its line, but will have also acquired an asset of great advertising value for the fast trains which it operates between Chicago and the ports of New York and Boston. The railroads are beginning to recognize that they can capitalize the safety value of automatic train control.

Well Planned

COMPARED with many large American cities Los Angeles, Calif., has an unusually complete and well-planned system of garbage and refuse disposal. Garbage is sold by the city to a company which transports it to the country and feeds it to hogs. General refuse goes to a city-owned sorting plant where materials of commercial value are salvaged. Refuse from the business goes to a large incinerator as described in our issue of July 14, p. 54. City collection is the rule. Whether this or some other threefold system of disposal would be desirable for other large cities is a question for local determination. At Los Angeles it is the outgrowth of long experience and careful engineering study. The latter is too seldom given to the garbage and refuse disposal problem in our cities and when given the conclusions are not always followed by governing bodies.

Useful Bidding Practice

INCREASED competition and better safeguarded contractors are being secured by several state highway departments when a group-letting is held by allowing the low bidder on any contract of the group to withdraw bids he may have made on remaining contracts. If, for example, there are 13 contracts in the group-letting and contractor *X* puts in a bid on contract one and also on one or more of the dozen other contracts he can if he proves low on contract one withdraw the other bids. This permits the small contractor to put in a bid on every contract of the 13 which he thinks he can handle and still be obligated only for the first on which his bid is low. The contractor's chance of getting a contract is increased, competition is increased and no bidder is compelled to overextend himself by taking more than one contract if that is all he is financed and outfitted to carry on. Contractors who have had experience with it generally commend this practice. The method calls for a somewhat different lineup of the highway department procedure in receiving bids. The low bid has to be officially determined and announced as each contract is considered and this may, at times, slow up the reading of bids. Ordinarily the delay is not great. During a reading witnessed recently in Pennsylvania not five minutes elapsed after any set of bids was read before the official announcement of the low bid was made. This called for a concentration of computers, perhaps a dozen, and the delivery to them of each bid as it was read. The official announcement of the low bidder obligates the department in no way to award him the contract. All the time can be taken that is desired to check up, compare and investigate bidders as the conditions may demand or the custom may be.

A West Coast Development

QUITE a remarkable situation has developed in the building field on the Pacific Coast, due to the fact that the insurance companies have apparently decided that they do not want large amounts of structural earthquake insurance. As reported in our last issue, heavily increased insurance rates were recently put in force. In connection with the new schedule the underwriters are stipulating terms much less favorable than have been customary; thus, the owner must carry his own risk as to the first 10 per cent of damage in any earthquake, and if he takes earthquake insurance at all he must cover at least 70 per cent of the value of the building, the rate being maximum for this coverage and decreasing thence to a 90 per cent coverage. These circumstances introduce so decided a change of conditions into the field of building finance as to have serious effect on building activity.

Not only are the rates high and the terms severe, but it is not always possible to get as much insurance as is desired or as may have been provided for in the financial plan under which the structure was built. On a $5,000,000 office building recently completed in San Francisco, for example, those who financed the project had been promised that earthquake insurance totaling $3,000,000 would be carried, but at the time this is written insurance companies have not been willing to take more than $1,000,000 on the structure. Other instances testify to the same situation. Anticipation of similar difficulties has undoubtedly had an adverse effect on a number of projects for erecting large office buildings. Capital is very likely to conclude that "if the risk is so bad, we won't invest."

Fortunately, this awakening to the earthquake risk will have certain constructive effects. Waiving the question of whether the new insurance rates are too high, the attitude taken by the companies will unquestionably bring about a reaction in the form of improved structural design. A simple calculation suffices to show the advantage of this: On a million-dollar concrete building an additional insurance charge of over $6,000 per year must be paid under the new rate; capitalizing this at 6 per cent, we have a sum of $100,000, an amount which would provide material protection against earthquake damage if applied judiciously at the time of construction. Banking interests have been assured by structural engineers that a moderate increase of cost can make a building much safer against damage from earthquake shocks.

One phase of the effect is seen in the present leaning of the Savings Bank Association toward abandoning the earthquake insurance requirement on new structures if the first cost includes an allowance for special shock-resisting design. So far as new construction is concerned, this would indeed be a very reasonable plan, since, with the help of competent engineering, the owner may thus obtain a degree of rigidity and stability in proportion to what he is willing to pay for, while, on the other hand, the insurance companies will probably be as well satisfied in being relieved of the necessity of insuring. It would still remain necessary to work out a solution for buildings already constructed and occupied. Unless some feasible adjustment could be made for these, a rent differential would result between new and old buildings; the owners of the latter would necessarily pass on to their tenants the high insurance rates in the form of an increased rental charge.

Progress in Flood Relief

RELIEF of the flood sufferers in the Mississippi valley, repairs to the damaged levee system, and the collection of data for use in preparing a comprehensive plan of flood relief, are all proceeding efficiently. Secretary Hoover's recent report to the President draws attention to part of this work; the remainder is going on almost unnoticed. He points out that the Red Cross has sufficient funds to provide food and shelter for those who cannot take care of themselves and to aid in re-establishing the people on their lands as fast as they are freed from the flood. Mr. Hoover estimates that even as late as Nov. 1 the Red Cross will still have $3,000,000 with which to continue relief work. This sum should be adequate until such time as Congress can provide additional funds if more are needed. Secretary Hoover does not minimize the seriousness of the situation for the people in the flooded areas, particularly those who have taxes and mortgage interest coming due, but their problems are such as can be worked out without any immediate federal action.

As to the river work, the Mississippi River Commission has enough money to begin repair work on the damaged levees without calling upon the local levee boards for contributions and hopes to get an added sum of $2,000,000 from which it can make loans to the local boards which are without funds.

The repair work calls for and is receiving prompt action. Contracts for closing most of the breaches in the levee system already have been let and contractors will be on the ground as soon as it is possible to begin work. If, as the work progresses, the Mississippi River Commission finds that it needs or can use additional sums to advantage in restoring the damaged levees and strengthening the weak places, the administration should see to it that such money is made available. To do otherwise would be but courting a repetition of this year's disaster.

Final action on a plan for controlling future floods in the Mississippi River is not possible at the present time as the data required in working out the solution are not yet available. Secretary Hoover has indicated that he does not look for any radical change in the present policy other than an extension of the jurisdiction of the Mississippi River Commission to the tributary rivers, strengthening the levee system, the use of a spillway, or spillways, on the lower river, the development of storage reservoirs wherever possible and the setting aside of overflow basins. He is certain that the country is willing to spend large sums upon a carefully thought out plan which will assure the low lands of the delta regions freedom from further flooding. Data upon which such a plan is to be based are being collected by the War Department in collaboration with other federal departments. The Mississippi River Commission is obtaining the necessary information to revise its plans for the levee system in the light of the recent flood. The Spillway Board is about ready to make its report. District engineers throughout the valley are making rapid surveys of all possible reservoir sites in their respective districts. The Department of Agriculture, through the Forest Service, is preparing a report on soils and forest cover throughout the whole valley preparatory to making a study of their effect upon stream flow. Whether Congress decides to appoint a special board to report upon the flood problem or whether it will place the responsibility for such a report with the Mississippi River Commission is of no immediate concern. We would prefer to see a separate board appointed. In either case, by the time Congress has convened in December most of the data needed for a study of the problem will be available.

Technical Crystallization

TECHNICAL societies have grown remarkably in recent years. Even at first glance at this growth one may recognize that there is in progress not a chance movement but a transformation resulting from definite and significant forces. All groups of technical men are growing more rapidly than the profession itself. General engineering societies share this growth with the various specialized organizations. Plainly, a crystallization is going on in the technical field, an agglomeration of individuals into larger and more powerful units.

What does this movement signify? A spontaneous drift of the individuals, in the main uninfluenced by propaganda or solicitation, it arises obviously from a conviction that strength lies in union. But if we ask why the engineer should seek for a stronger position in the world, we face a more fundamental question. The development of human affairs tends to involve him in an ever broader range of activities and relations. Thereby he finds himself confronted by changing conditions and increased difficulties — conditions and difficulties quite different from those known to his professional predecessors. As these difficulties become more complex and formidable, he finds ultimately his own judgment and conscience, guided only by the precedent set in the past, insufficient to deal with them. In this conjuncture he is bound to seek the help of his fellows, and he finds the sought-for co-operative strength in the technical society.

If this is the true interpretation of the current society growth, it is a matter for serious and sober consideration by those organizations. They are not merely gaining members, they are gaining new responsibilities and new functions. Their entire relationship to their constituency is coming to be of new kind. The very fact of professional crystallization means a transfer of function: the individual turns over his problems and obligations to his group, and tacitly asks that it deal with them in his stead. Accordingly, unless the organization takes up the new functions it is in peril of failure.

The responsibility of class representation has hitherto rested lightly on technical societies, so lightly that most of them preferred to ignore it. Accordingly they are little prepared now to admit the responsibility or act upon it. In the main they lack not only machinery and plan but even the courage to function as representative groups. But if the new responsibilities are growing from day to day, they can not long be evaded with impunity.

For the society, then, the present is more than a time of growth, it is one of transformation. New and greatly enlarged requirements impose themselves upon the organization and the latter is bound to reshape its activities accordingly. The concepts and purposes of group activity which grow out of the changing conditions of professional life are not as yet fully definite, but they are slowly taking form. That they may be duly taken into account in realigning society functioning, there is need for broadest sympathy and keenest vision in the society councils.

Combined Railway Bridge and Dam Built at Outlet of Grand Lake, Newfoundland

Hollow Dam Built on Foundation of Porous Rock—Underlying Rock Grouted—Long Temporary Crib Dam Built to Unwater Stream During Early Stages of Construction

By A. B. McEwen
Chief Engineer, William I. Bishop, Ltd., Montreal

ALTHOUGH much has been written in the way of general descriptions of the recent development in the Humber area in Newfoundland by the Newfoundland Power & Paper Co., an accurate description of the combined railway bridge and hollow reinforced-concrete dam 1,050 ft. long and 80 ft. high, which was built across Junction Brook, has not heretofore been published. This work is of interest, as it is one of the larger dams of this type so far constructed and also because the rock on which the dam was built was of a very soft and porous nature, necessitating extensive grouting to prevent seepage under the cutoff.

The dam in question is part of the power development scheme shown in Fig. 1 which includes a 7-mile canal with intake gates, forebay, headgates, penstocks 4,000 ft. long, and a power house at Deer Lake operating under a head of 250 ft. The object of the dam is to raise the level of Grand Lake by about 25 ft. so that water will flow through the canal, and also to create a storage reservoir to take care of the seasonal variations of inflow into the lake. The location selected for the dam was chosen because it was the only point where the river banks were sufficiently high to raise the lake to the desired level.

During the latter part of 1922 some preliminary designs and estimates of cost of hollow dams were made up for comparison with the solid or gravity type and early in 1923 it was finally decided that the hollow reinforced-concrete type would be used. Detailed design was made in April and after calling for tenders the contract was awarded to William I. Bishop, Ltd., of Montreal on June 7, 1923.

During the winter of 1922-23, a crib dam, Fig. 4, was built at the point where Junction Brook flows out of Grand Lake. The object of this dam, which had 22 stoplog sluices, was to shut off the flow in Junction Brook by storing the water in the lake, thus allowing the construction work in the stream bed to be proceeded with.

Conditions at the Dam Site—From preliminary investigations carried out by the owners at the dam site, it was believed that the foundations of the dam would be on a solid rock, free from any stratification and cracks, the rock being a coarse sandstone, almost a conglomerate, containing pebbles up to 2 or 3 in. It was assumed that this rock would safely carry a load of 15 tons per sq.ft.

When the preliminary designs were being made, the information regarding the areas of Grand Lake and the watershed was not very complete. The lake was assumed to have an area of 135 sq. miles and a watershed of about 2,000 sq. miles. It was estimated that the area of the lake, when raised to El. 377, would be 165 sq. miles at least. Measurements of the flow of Junction Brook had been taken since 1914 and the average flow was found to be 4,890 sec.-ft., while the maximum recorded flood was 16,600 sec.-ft. Before the final designs were made, however, a flood of 24,000 sec.-ft. occurred in the spring of 1923. It was therefore decided to provide spillway capacity for a flood of that magnitude, since the available storage of the lake gave a sufficient factor of safety, so long as the gates were intelligently operated.

As the crest of the dam was of a shape favorable to efficient discharge and since the piers were thin and the upstream ends pointed to reduce end contraction, the discharge formula $Q=CH^{1.5}(1-.05nH)$ was used with value of C varying from 3.30 to 3.90 as the head varied from 1 ft. to 10 ft.

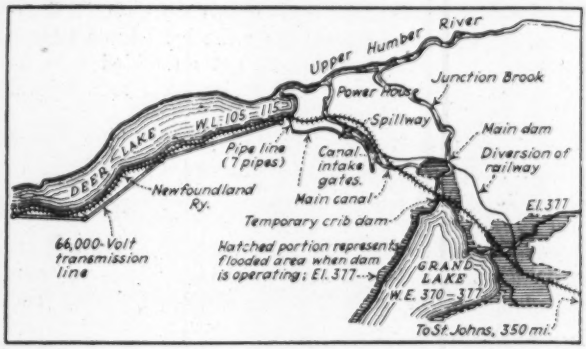

FIG. 1—GENERAL PLAN OF THE POWER DEVELOPMENT

A series of calculations was made to show the effect of opening the gates at different stages during the maximum recorded flood and it was shown that there was no difficulty in handling the maximum recorded flood with but a small rise in the lake level, even with an assumption of 160 sq. miles for the area of the lake when full. When the survey of the lake was actually made, it was discovered that the flooded area would be 215 sq. miles, thus allowing much greater freedom in the operation of the spillway gates. It might also be mentioned here that there have been no actual precipitation records taken within 100 miles of this development; but from the records at Port aux Basques and Grand Falls it was assumed that the annual precipitation would vary from about 40 to 55 in.

Design of the Dam—Owing to the fact that the Newfoundland winters are not very severe and also that the dam was favorably located, it was considered that the ice pressures would probably not be severe and a value of 10,000 lb. per lin.ft. against the spillway section where faces of piers and gates are vertical and 5,000 lb. per lin.ft. on the bulkhead section where the deck is inclined, acting 1 ft. below the high water level of the reservoir, was assumed.

The Newfoundland Government Ry., which crosses

the dam, has a 42-in.-gage track and its engineers decided that Coopers E-40 loading with 50 per cent impact was sufficient to design for. An equivalent loading was used in actually making the design. The railway girder was made in the form of a trough with the ties laid in stone ballast.

The standard specifications of the American Society of Civil Engineers were used for the most part in making the design, with the exception that the allowable tension in the steel was taken as 15,000 lb. per sq.in. and the maximum compression in the extreme fiber of concrete as 550 lb. per sq.in. for 1:2:4 concrete. Fig. 3 shows cross-section through the spillway and bulkhead sections of the dam.

Start of Construction—The contract for the construction of the dam was awarded on June 7, 1923, and the necessary plant was shipped immediately by boat from Montreal, Canada, to Port aux Basques, Newfoundland, and trans-shipped from there to the site by the Newfoundland Government Ry., the first carload arriving on June 26. Two carloads of lumber had previously been unloaded at the end of the siding, and by making use of a box car with a stove in it for the accommodation of a small gang, construction of camps was started. As fast as sleeping accommodations could be erected, more men were taken on. As the Newfoundlanders cooked their own meals, the camps were built as a series of small huts divided in sections which would accommodate six or eight men. A two-story bunkhouse was built for the accommodation of foremen and mechanics who were brought in from Canada, and a cookhouse was also built for them. Later on it was decided to provide a cookhouse for the local labor, because it was found that the men themselves actually preferred to have this done.

As soon as a sufficient number of men could be housed, excavation work and plant erection were commenced. Clearing had been done during the previous winter.

The plant layout was adapted to the very small area available. It consisted of the following major items: two cableways with 980-ft. span, two 1-yard mixers, three 50-hp. locomotive-type boilers, one compressor, capacity 345 cu.ft., one stiff-leg derrick with hoist, one traveling derrick, and also complete carpenter, machine and blacksmith shop equipment, an electric light plant and the necessary smaller equipment such as pumps, air drills, dump cars, etc. A novel feature of the work was that the plant and materials were laid out in such a manner that no horses whatever were required. The plant was completely erected and ready for operation on Aug. 10.

In the meantime a study was made of the records of flow in Junction Brook to determine for what length

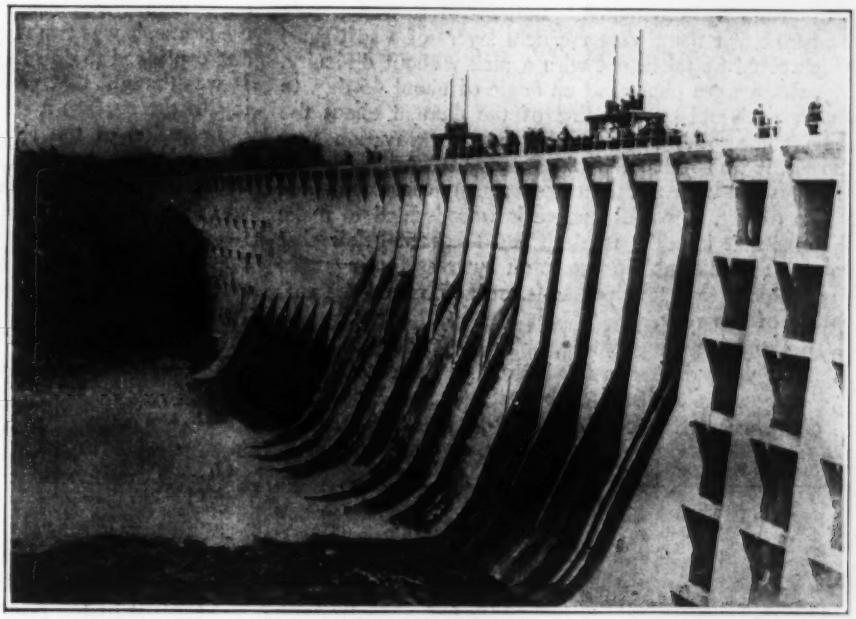

FIG. 2—DOWNSTEAM SIDE OF THE COMPLETED DAM

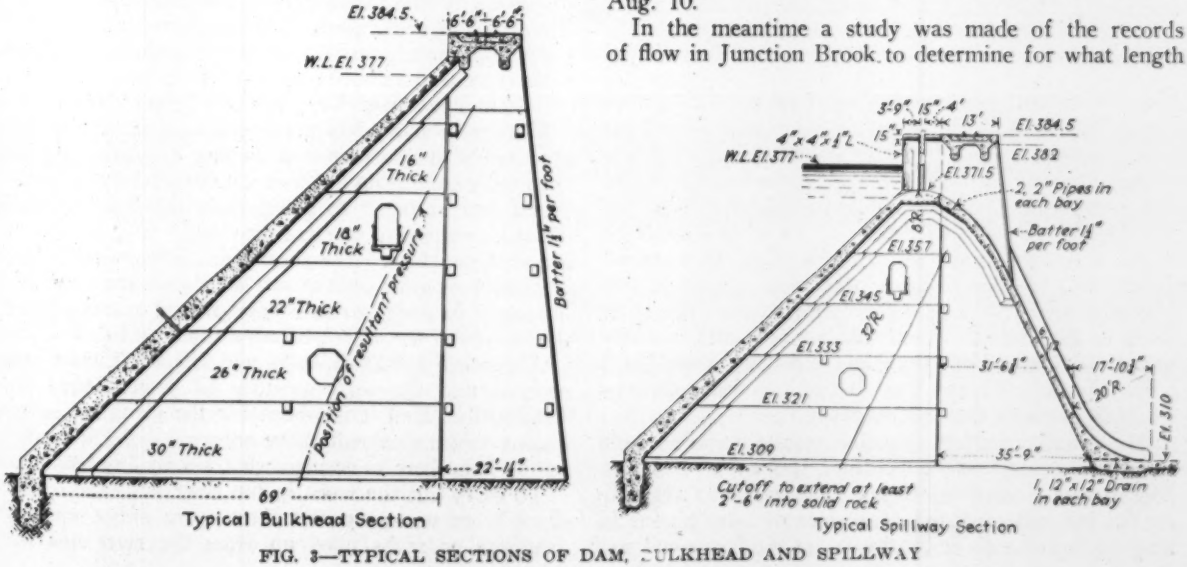

FIG. 3—TYPICAL SECTIONS OF DAM, BULKHEAD AND SPILLWAY

of time the water could be stored in Grand Lake by the crib dam. It was found that only three months would be available for clearing of stream bed, excavating for buttress footings and cutoff and the placing of concrete in the cutoff, the buttresses to El. 321 and the hearth. The deck slabs were to be left off to allow the spring flood of 1924 to pass through the dam. The crib dam was closed on Aug. 9 and work was immediately started on excavation for cutoff and buttress footings in the stream bed.

By that time it had been discovered from the excavation done on the banks that the rock was much softer than originally anticipated. In general it was a soft sandstone, but there were frequent layers of a soft shale which could be taken out with a pick without difficulty. The strata were pitched at an angle of about 45 deg. to the vertical and cut the line of the dam at about the same angle. As soon as the cutoff excavation was started, it was found that the seams between the layers of sandstone were not tight and in many cases contained a film of silt. In consequence it was decided to make the cutoff at least 10 ft. deep and to grout below that point. The allowable pressure on buttress footings also was reduced to 6 tons per sq.ft. on account of the soft nature of the rock.

To carry out the grouting, holes 20 ft. deep at 10-ft. intervals were drilled in the bottom of the cutoff. Between these, holes 10 ft. deep were put in. Pipes 2 in. in diameter were placed in the 20-ft. and 1½-in. pipes

FIG. 4—TEMPORARY CRIB DAM ON GRAND LAKE

in the 10-ft. holes and carried up above the level of the top of the cutoff. The space between the pipe and the hole was carefully calked with oakum to prevent any chance of grout getting into the hole when the cutoff was being poured. After six 20-ft. holes had been put in, a test was made to determine to what extent the seams were interconnected. All the pipes were capped except No. 1. Air pressure was then applied to this pipe and when the caps were removed from the other pipes in turn it was found that air appeared in every case, the quantity diminishing as the distance from No. 1 pipe increased, showing that air had traveled a distance of 50 ft. through the rock seams.

The actual grouting operation was not started until most of the cutoff on the west half of the river had been poured and allowed to set up. The gun was made up on the job and consisted of a piece of 6-in. pipe 6 ft. long capped at both ends; the cap at the lower end was tapped for a 2-in. pipe and a short length of pipe with a union on the lower end was attached, so that the gun could be connected to the grout pipes. The upper end was tapped in the same manner and connections arranged so that the gun could be filled with grout or air pressure applied. Three pet-cocks were screwed into the side of the pipe so that the level of the grout could be determined approximately. A gun made up out of 4-in. pipe was used for grouting the 1½-in. pipes.

Work was started at about the middle of the stream bed. All holes except the one being grouted were kept capped. In the case of the first hole, instead of being able to fill the gun and apply pressure to force it into the seams, it was found that the grout ran in quite freely and continued to do so until 90 pails had been poured in. It was thought that perhaps the grout was merely coming to the surface a short distance away, but a careful examination of the river bed for some distance on all sides of the hole was made and no sign of grout could be discovered. Consequently work was continued and it was soon found that it required a slight pressure to force the grout in. The grout was thickened and work carried on and finally after working for eight hours the hole was plugged and successfully withstood a pressure of 105 lb. per sq.in.

The record of this first hole was as follows:

Time	Mix Cement and Water	Number of Pails	Cement Used, Lb.	Pressure Required, Lb
Start 8:15 a.m.	1:4	90	400	Nil
Sept. 25, 1923	1:4	40	180	15
	1:3	90	500	15 to 45
	1:2	224	1,600	15 to 45
	1:1½	60	536	15 to 45
	1:1	64	700	15 to 45
Finish 4:50 p.m.	1:½	70	880	105
			4,796	

Nearly 4,800 lb. of cement were put into this first hole and no trace could be found of any grout appearing at the surface of the river bed.

Having successfully plugged this hole, as might be expected the next few took practically no grout. Only one hole was found which took more cement than this first one. It was 140 ft. distant and required 5,600 lb. to finally block it.

The use of sand in small proportions was attempted with the grout, but this very quickly plugged up the hole and it was feared that it interfered with the effectual grouting of all the seams and consequently it was discontinued. Some seams did open to the surface not far from the hole being grouted. In such cases a very thick grout was forced into the seam and allowed to set for a short time. This appeared to plug the seam very quickly and grouting of the hole could then be carried on.

If air was allowed to get into a hole, it very quickly appeared at the surface in a number of places and also apparently opened up the seams, since a hole was usually found more difficult to grout after this had occurred. This also seemed to increase the danger of grout appearing at the surface. The short holes in practically every instance took very little grout, but they were considered necessary in order to take care of any seams close to the bottom of the cutoff, between the deep holes.

Altogether 170 20-ft. holes and 171 10-ft. holes were grouted and the total quantity of cement used was 141,760 lb. Had it not been for the grouting, serious leaks would undoubtedly have occurred under the cutoff, but as it is there is no sign whatever of any leakage.

To carry out the work in the river bed small cofferdams were necessary and these were either made of sandbags or rocks piled up from the river bed with

branches and earth in front of them. Owing to the open nature of the seams in the rock, these cofferdams were kept as far upstream from the dam as possible, advantage being taken of the higher ridges of rock to construct whatever additional barrier was required.

Buttresses—Buttress footings and cutoff were poured as rapidly as they could be excavated and for this purpose a hopper set up on a tower into which the cableway bucket dumped, was used.

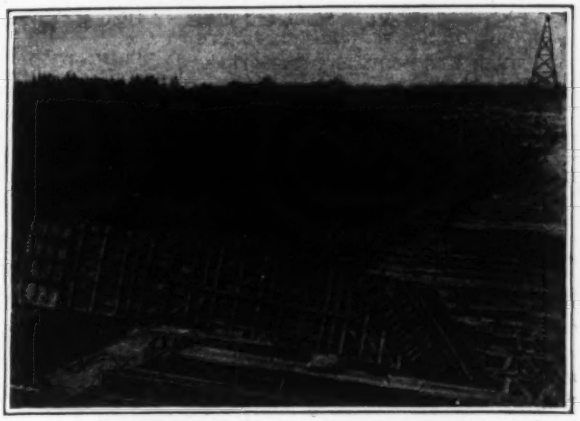

FIG. 5—MOVING BUTTRESS FORMS

Following this, forms were set up for buttresses to El. 321. Built up or panel forms were used, depending on the height of buttress that had to be poured. In pouring the buttresses and at a later date the decks and aprons, sectional platforms with tracks on which a car could be operated were placed on top of the buttress forms. The cableway bucket dumped into this car, which then deposited the concrete wherever it was desired.

During the first season sand and stone were not supplied by the owners at the desired rate and the work was consequently delayed and only the minimum amount of work necessary could be carried out during this year. This consisted of the cutoff from buttress 9 to 32, buttresses 7 to 34 to El. 321 and all the hearth. After the crib dam was opened, the second 12-ft. lift (that is from El. 321 to 333) of buttresses 12 to 32 was poured and excavation on both banks of the river was proceeded with. General appearance of the work at this time is shown in Fig. 6.

The sand supplied during the first season was not clean enough and a washing plant had to be installed at the dam. A more suitable pit was located and opened at the end of the season, to supply other work being carried on during the winter and also for use at the main dam the following season.

In general the construction plant was found to operate very efficiently. Sand and stone were dumped from a trestle close to the mixer plant, from whence they were picked up by a stiff-leg derrick with an orangepeel bucket and deposited in bins over the mixers. Cement was supplied from England in wooden barrels of 400 lb. each and was stored in the cement shed beside the mixer plant. Sand and stone were drawn from the bins into a charging hopper in which they were measured over the mixer. Cement was measured in small cars at the level of the mixer floor and these cars were hoisted and dumped automatically into the charging hopper. Cement barrels were carried out and dumped over the bank.

The mixed concrete was dumped into cars in front of the mixer plant and these in turn were pushed under the cableway which picked them up and transported them to the desired point.

The cableway operations were directed by means of both telephone and bells by signalmen located in towers on the west bank of the river. By this means concrete could be placed at a rate of from 15 to 20 batches per hour by each cableway, depending on the length of run the cableway had to make.

The cableway could pick up complete buttress forms and move them to new positions, Fig. 5. Reinforcing steel, stored by the railway siding under the cableways, was cut and bent at the yard, run under the cableway in a hand-car and by it picked up and transported to the place where it was to be used.

Buttress forms were made up of standard panels 10 ft. wide by 12 ft. 6 in. high, bolted together with the haunch form again bolted to these. The forms for the two sides were held together by means of 1-in. bolts which were well oiled so that they could be driven out of the concrete. After a buttress had been poured and had set sufficiently to be self-supporting the bolts were driven by using a ¾-in. follower and an air hammer.

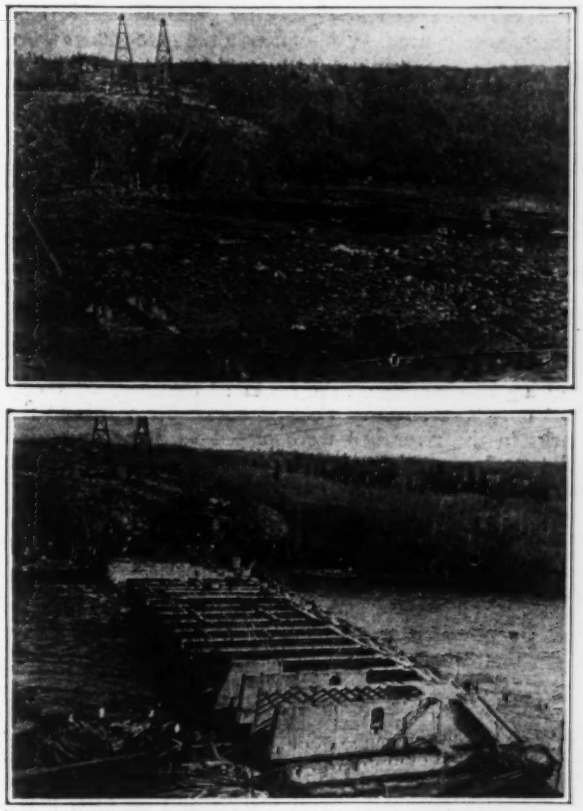

FIG. 6—EARLY PROGRESS ON THE DAM
Above, Site unwatered by closing dam shown in Fig. 4. Below, Same site three months later when crib dam was opened.

Deck Construction—The deck crest and apron forms were built in place on the under side and consisted of panel forms on the upper side. For the under form, channels placed back to back and made up so that the length was adjustable were bolted together and the ends supported in boxes in the buttress haunch. Two-inch

sheathing was placed on top of these. The outer form was held in place by channel irons, the ends of which were held down by means of bolts previously left projecting from the faces of buttresses. There were also bolts through the center of the slab. The bolts in the buttress faces were set in pipe sleeves with a washer and nut on the lower end and were afterwards screwed out and the holes filled with grout. The bolts in the center of the slab were driven out and the holes afterward stopped by means of dry pine plugs and cement grout. Fig. 7 shows deck forms and bolts for anchoring down top form.

The joints between the tongue of the buttress which projected through the deck slab and the deck slab were made watertight by means of a copper strip projecting into each. On the horizontal joints in the deck slabs, great care was taken to make sure that all laitance was removed and the old concrete was given a thorough wash of neat cement grout just previous to the placing of new concrete.

Since the spillway buttresses projecting above the crest were made thin, to offer as little obstruction as possible to the discharge, it was not possible to leave cheeks and place the embedded steel for the gates after the buttresses were poured. Consequently the gate guides were designed with a very rigid temporary cross-bracing, which held them in place accurately. Three-inch pipes were placed behind the guides in the buttress, to permit the thawing of ice either by small electric heaters or by steam in case the gates had to be raised in winter. The gates, which are of the plain sliding type, have bronze bearing strips, as do also the gate guides. The gate hoists, two of which were installed, are motor driven and travel on rails set in the walkway slab.

The work for the season of 1924 had to be carefully scheduled, as the rate of progress was controlled by the rate at which concrete could be poured by the cableways. Operations commenced on April 15 and excavation and pouring of concrete on the banks of the river were carried on. The river was closed off on June 18 and the decks in the river bed were placed with the exception of four bays which were left open to allow the river to flow through as long as possible and thus keep the level of the lake down. On July 12 the crib dam was again opened and water allowed to pass through the four bays left open. The water was again shut off on July 29 and the deck slabs poured in the four bays previously left open and then on Aug. 15 the crib dam was again partially opened and water allowed to flow through the two closure bays while the upper sections of the dam were being constructed.

The placing of concrete commenced on May 1 and by Sept. 17 was practically completed. Buttresses were finished on Sept. 4, deck slabs and railway girder on Sept. 13 and corewalls on Sept. 23. The railway girder was tested with two engines on Oct. 5 and on Oct. 7 the bridge was opened for main line traffic, and the removal of the steel truss spans of the old railway bridge started. By Oct. 14 sufficient headway had been made on the removal of these girders that it was possible to block the closure bays and the east bay was closed on this date and the west one on Oct. 16.

To make the closure, stoplog gates were first dropped into grooves provided in the concrete. These gates were wedged tightly into place and calked. Forms were then built for the concrete and pipes put in to carry the leakage from the space between the stoplogs and the upstream form through the green concrete. After the concrete had set up, the pipes to carry off leakage were plugged by means of a wooden plug on a rod. The plug was pulled into the upstream end of the pipe, the rod then unscrewed from the plug and the pipe filled with grout and capped.

After the dam was closed, the water was allowed to rise slowly, as the crib dam was not opened until the level of the water was nearly the same on both sides.

In spite of the very porous nature of the underlying rock, there was no apparent seepage. It is believed this was largely due to the careful manner in which the grouting was carried out. It was also found that there was no leakage through the dam itself, due to the care exercised in making construction joints and to the use of the copper seal at the expansion joints.

The dam as originally designed provided for an apron extending 50 ft. downstream below the foot of the overflow; in addition to which there was to be a tumbling basin formed by a rough crib dam some distance downstream. Under the orders of the owners' engineers, the length of the apron was reduced to 25 ft. and the downstream crib dam entirely omitted.

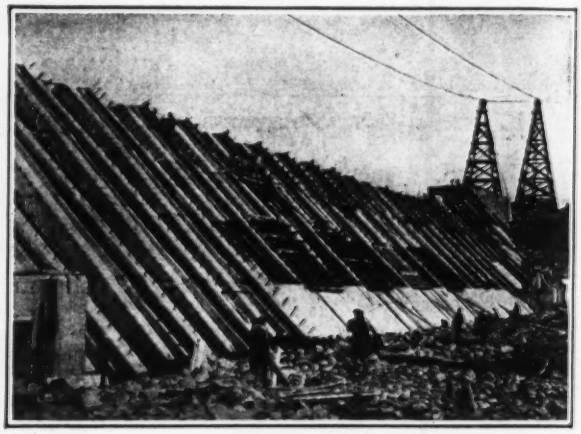

FIG. 7—POURING SLABS ON UPSTREAM FACE

After the first season of operation, the bed of the river was washed out to a depth of 7 or 8 ft. below the toe of the apron. This was repaired by concreting the upstream face of the exposed rock below the toe and the crib dam was placed where originally intended. Since then no further trouble has developed.

Sir Alexander Gibb and Partners, of London, England, were the consulting engineers for the British government, and the design and construction were carried out to their approval. Sir W. G. Armstrong, Whitworth & Co. Ltd., of London, England, were the general contractors for the Newfoundland Power & Paper Co. William I. Bishop, Ltd., of Montreal, Canada, owners of the Ambursen Hydraulic Construction Co., Ltd., of Canada, designed and built the combined dam and bridge as subcontractors to the Armstrong, Whitworth Co. J. L. Allison and the author were in charge of the design, the author acting as resident manager in charge of construction.

The total cost of this structure was approximately $880,000. The principal quantities involved were: Earth excavation 3,400 cu.yd., loose rock excavation 2,300 cu.yd., rock excavation 12,500 cu.yd., forms 582,000 sq.ft., reinforcing 1,650,000 lb., concrete 29,000 cu.yd., earth embankments 5,100 cu.yd.

HORSESHOE SPILLWAY, SHERMAN ISLAND DAM, HUDSON RIVER

Pondage Important Factor in Spillway Design

Length of Spillway May Be Reduced When Pondage Is Large—Flood Crest Reduced and Retarded by Accumulation of Water Above Spillway

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THE spillway capacity needed at a given dam site is usually assumed as equal to the maximum natural stream flow expected at that point. This assumption always errs on the side of safety due to ponding a portion of the flood flow in accumulating a head on the spillway crest. If the reservoir has a large water surface area, this error may become considerable, and may result not only in an unjustifiable waste of water but also in loss of the advantage gained in flattening out a flood curve by restricting the flow. Two methods of studying flood conditions at a given spillway to avoid such errors are given in the following computations.

For any reservoir let H equal the elevation of reservoir water surface above the spillway crest and assume reservoir contents above the crest to be those shown in Table I. Let Q equal flow over spillway weir in sec.-ft. and let b equal net length of crest in feet. Then,

$$Q = 3.087\, bH^{3/2} \qquad (1)$$

A larger coefficient is quite commonly used in the above formula in place of 3.087. The writer believes, however, that 3.087 is the proper coefficient as applied to reservoir flow lines because H is the weir head at a point in the reservoir pool a long distance above the weir, where the velocity head may be assumed as zero. If H is measured at a point near the weir there is always apt to be considerable velocity head, even if the cross-section area there is very large, because there is quite certain to be some surface velocity. In that case the coefficient in equation 1 may be 3.33 or even greater—but the weir head in the quiet waters of the pool would then be greater than H.

The correct general form of equation 1 is $Q = 3.087\, b(H + h)^{3/2}$, in which h is a head addition corresponding to the effective velocity of approach. This effective velocity of approach will be greater than Q/a unless the velocity is uniformly distributed throughout the cross-section area, a, at the point where H is located.

If $Q = 3.33\, bH^{3/2}$, this means that $3.33\, H^{3/2} = 3.087\, (H + h)^{3/2}$, or $h = 0.052\, H$.

The coefficient 3.087 in equation 1 is established as follows: H is the weir head at some point in the reservoir pool where there is no velocity of approach in any portion of the stream section.

Let d = depth of water on the weir crest, and h_v = velocity head over the crest.

Then, neglecting friction losses above the weir, we have from Bernoulli's theorem,

$$H = d_v + h_v \qquad (A)$$

Regarding the stream section on the weir crest as a "critical section," flowing without hindrance or limitation from any other section above or below, then the discharge over the weir is the maximum possible flow for the particular value of $d_v + h_v$ under which the weir is operating, and hence $h = \frac{1}{2}\, d_v$ for a rectangular weir. Then from equation A,

$$H = 3/2\, d_v \text{ or } d_v = 2/3\, H$$

$$\text{and } Q = av = bd_v\sqrt{2gh_v} = 3.087\, bH^{3/2} \qquad (1)$$

Assume $b = 400$ ft.

Then from (1), $\qquad Q = 1{,}235\, H^{3/2} \qquad (2)$

Values of Q from equation 2 are given in column 3 of Table I. Coincident values of storage above crest and the corresponding Q over the spillway are plotted as curve ABC in Fig. 1, from columns 2 and 3 of Table I.

Table II is a tabulation of assumed natural stream flows at the dam site. The maximum natural daily flow during the period tabulated is seen to be 33,500 sec.-ft., on March 28. Even under the severe assumption of a full reservoir at the beginning of the flood season and

no discharge except spillage, the maximum daily flow over the spillway, as analyzed below, is seen to be only 21,500 sec.-ft. instead of the maximum natural flow of 33,500 sec.-ft., and the peak of the flood was delayed from March 28 to March 30. It is assumed, further, that the reservoir water level rose to the crest of the spillway on March 10, after which there is no draft except the spillage.

Fig. 3 represents a graphical method of analysis by hydrographs and Table III represents an analytical method based on the same data and assumptions as Fig. 3.

In Fig. 3, line A is a hydrograph of the natural flow as plotted from Table II and line B is the corresponding hydrograph of the flow over the spillway, plotted from the following principles: The area between hydrographs A and B between any two dates represents the difference between inflow and outflow during that time. If A is above B this difference is storage (positive) and if B is above A the difference is depletion (negative).

The total area (algebraically) between A and B to the left of any vertical line represents the total storage above the spillway crest on the date at which the vertical line is located; and the vertical ordinate of curve B on this same date gives the simultaneous value of the spillway discharge rate, Q. Hence at every point of the hydro graph B, its vertical ordinate and the area between A

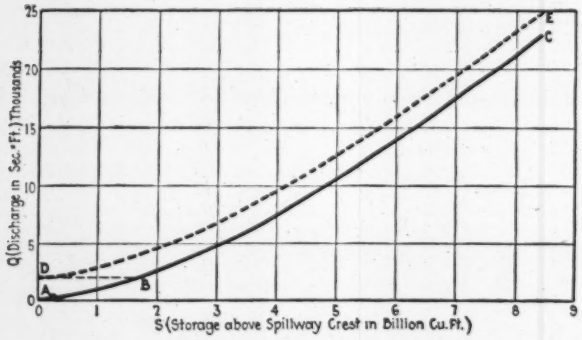


FIG. 1—SPILLWAY DISCHARGE FOR GRAPHICAL TREATMENT

and B to the left of that ordinate must satisfy Fig. 1, which gives coincident values of Q and the storage.

Hydrograph B is thus constructed step by step from left to right. Each new point is located by trial and moved upward or downward as dictated by Fig. 1. For instance, the hatched area at the left end of Fig. 3 is 1.72 sq.in. 1 inch horizontally represents 5 days, = 432,000 sec. 1 inch vertically = 5,000 sec.-ft. Hence each sq.in. equals 2.16 billion cu.ft. and the hatched area equals 3.72 billion cu.ft. of storage. This corresponds to a spillage of 6,700 sec.-ft. as per Fig. 1 and hence checks the ordinate of curve B at the right end of the hatched area of Fig. 3.

Likewise, the area between curves A and B to the left of point p_1 = 8.1 billion cu.ft. = 21,500 sec.-ft. The negative area between points p_1 and p_2 = 5.2 billion cu.ft. and hence the area to the left of p_2 = 8.1 — 5.2 = 2.9 billion cu.ft. = 4,650 sec.-ft., etc.

Curves A and B always cross each other at maxima and minima points of curve B.

When the hydrograph B returns to zero flow over the spillway the positive and negative areas will balance. This, of course, cannot occur as long as there is any

TABLE I—RESERVOIR STORAGE AND SPILLAGE FOR VARIOUS HEADS ON THE SPILLWAY

H Reservoir Head on Spillway Crest, Ft.	S Reservoir Storage above Spillway Crest, Billion Cu.Ft.	Q Over 400-Ft. Spillway from Equation 2, Sec.-Ft.	Q Spillage in Billion Cu.Ft. per Half Day, 0.0000432 Q	$S + Q$
10	12.20	39,054	1.687	13.89
9	10.95	33,345	1.440	12.39
8	9.70	27,945	1.207	10.91
7	8.45	22,873	0.988	9.44
6	7.20	18,150	0.784	7.98
5	6.00	13,809	0.596	6.60
4	4.80	9,880	0.427	5.23
3	3.60	6,417	0.277	3.88
2	2.40	3,493	0.151	2.55
1	1.20	1,235	0.053	1.25
0	0	0	0	0

inflow, if the spillage is the only draft from the reservoir. A chronological profile of the spillway head, H, may be plotted from hydrograph B by reference to an $H - Q$ curve prepared from columns H and Q of Table I. The maximum spillway head is of course coincident in time with the maximum spillage on March 30. The maximum spillage of 21,500 sec.-ft. corresponds to a spillway head of 6.71 ft., as interpolated from Table I, while a spillage equal to the maximum natural flow of 33,500 sec.-ft. would require a spillway head of 9.03 ft.

The above analysis is repeated in Table III analytically, requiring no graphs. The table is prepared in the following manner:

Let S_x = billion cu.ft. storage above spillway crest at the beginning of any day.

S_y = billion cu.ft. storage above spillway crest at the end of the day. (Time interval = 24 hours = 86,400 sec.)

Let the corresponding values of Q over the spillway be denoted by Q_x and Q_y, respectively (sec.-ft.).

The outflow during the day in billion cu.ft. = $\frac{Q_x + Q_y}{2} \times \frac{86{,}400}{1 \text{ Billion}} = 0.0000432\,Q_x + 0.0000432\,Q_y$ $= q_x + q_y$, in which $q = Q$ expressed in billion cu.ft. per half day.

Let F = inflow during the day in billion cu.ft.

Then $S_y = S_x + F - (q_x + q_y)$.

Gathering the unknown quantities on the left we have

$$(S_y + q_y) = F + S_x - q_x \qquad (6)$$

Coincident values of q and $S + q$ are plotted as curve ABC in Fig. 2, from columns 4 and 5 of Table 1.

From Fig. 2 we obtain q_y after solving 6 for $(S_y + q_y)$. Then $S_y = (S_y + q_y) - q_y$. S_y and q_y become S_x and q_x, respectively, in the next application of equation 6. Columns 1 and 2 of Table III are identical with Table II excepting that the natural flows, F, are given in billion cu.ft. per day instead of in sec.-ft. Columns 3, 4 and 5 of Table III indicate the operations in the suc-

TABLE II—ASSUMED NATURAL STREAM FLOW

Day	Daily Flow in Sec.-Ft. March	April	Day	Daily Flow in Sec.-Ft. March	April
1	1,000	11,300	17	7,580	5,330
2	980	9,840	18	7,580	6,400
3	970	8,500	19	6,690	6,120
4	960	7,280	20	6,690	5,080
5	900	6,690			
6	870	6,400	21	6,690	4,130
7	860	5,850	22	8,180	3,270
8	850	5,330	23	9,500	2,710
9	864	4,600	24	8,820	2,210
10	1,270	3,900	25	9,160	1,760
11	1,700	3,470	26	17,000	1,500
12	1,900	3,900	27	28,300	1,220
13	2,210	4,130	28	33,500	1,160
14	3,900	4,130	29	26,900	1,110
15	5,080	3,680	30	19,500	1,010
16	6,690	3,470	31	13,700	

TABLE III—EFFECT OF RESTRICTED SPILLWAY ON NATURAL FLOW

	March						April					
	2	3	4	5	6	7	2	3	4	5	6	7
		Storage		Spillway Discharge				Storage		Spillway Discharge		
Day	Natural Flow, Billion Cu.Ft. F	$S+q$ Eq. 6	Billion Cu.Ft. Storage above Spillway Crest, S $(S+q)-q$	Billion Cu.Ft. per ½ Day q Fig. 2	Daily Flow Billion Cu.Ft.	Daily Flow Sec.-Ft.	Natural Flow, Billion Cu.Ft. F	$S+q$ Eq. 6	Billion Cu.Ft. Storage above Spillway Crest, S $(S+q)-q$	Billion Cu.Ft. per ½ Day q Fig. 2	Daily Flow Billion Cu.Ft.	Daily Flow Sec.-Ft.
1	0.086	.....	.....	.....	.....	.....	0.976	7.578	6.850	0.728	1.543	17,860
2	0.085	.....	.....	.....	.....	.....	0.850	6.972	6.323	0.649	1.377	15,940
3	0.084	.....	.....	.....	.....	.....	0.734	6.408	5.835	0.573	1.222	14,140
4	0.083	.....	.....	.....	.....	.....	0.629	5.891	5.383	0.508	1.081	12,510
5	0.078	.....	.....	.....	.....	.....	0.578	5.453	5.000	0.453	0.961	11,120
6	0.075	.....	.....	.....	.....	.....	0.553	5.100	4.690	0.410	0.863	9,990
7	0.074	.....	.....	.....	.....	.....	0.505	4.785	4.411	0.374	0.784	9,070
8	0.073	.....	.....	.....	.....	.....	0.460	4.497	4.157	0.340	0.714	8,260
9	0.075	0	0	0	0	0	0.397	4.214	3.904	0.310	0.650	7,520
10	0.110	0.110	0.107	0.003	0.003	35	0.337	3.931	3.651	0.280	0.590	6,830
11	0.147	0.251	0.245	0.006	0.009	104	0.300	3.671	3.421	0.250	0.530	6,130
12	0.164	0.403	0.393	0.010	0.016	185	0.337	3.508	3.273	0.235	0.485	5,610
13	0.191	0.574	0.559	0.015	0.025	289	0.357	3.395	3.167	0.228	0.463	5,360
14	0.337	0.881	0.851	0.030	0.045	520	0.357	3.296	3.082	0.214	0.442	5,120
15	0.439	1.260	1.207	0.053	0.083	960	0.318	3.186	2.978	0.208	0.422	4,880
16	0.578	1.732	1.647	0.085	0.138	1,600	0.300	3.070	2.874	0.196	0.404	4,680
17	0.655	2.217	2.092	0.125	0.210	2,430	0.461	3.139	2.935	0.204	0.400	4,630
18	0.655	2.622	2.467	0.155	0.280	3,240	0.553	3.284	3.070	0.214	0.418	4,840
19	0.578	2.890	2.710	0.180	0.335	3,880	0.529	3.385	3.160	0.225	0.439	5,080
20	0.578	3.108	2.908	0.200	0.380	4,400	0.439	3.374	3.150	0.224	0.449	5,200
21	0.578	3.286	3.071	0.215	0.415	4,800	0.357	3.283	3.069	0.214	0.438	5,070
22	0.707	3.563	3.318	0.245	0.460	5,320	0.283	3.138	2.934	0.204	0.418	4,840
23	0.821	3.894	3.614	0.280	0.525	6,080	0.234	2.964	2.774	0.190	0.394	4,560
24	0.762	4.096	3.797	0.299	0.579	6,700	0.191	2.775	2.605	0.170	0.360	4,170
25	0.791	4.289	3.971	0.318	0.617	7,140	0.152	2.587	2.435	0.152	0.322	3,730
26	1.469	5.122	4.710	0.412	0.730	8,450	0.130	2.413	2.273	0.140	0.292	3,380
27	2.445	6.743	6.128	0.615	1.027	11,890	0.105	2.238	2.113	0.125	0.265	3,070
28	2.894	8.407	7.559	0.848	1.463	16,930	0.100	2.088	1.978	0.110	0.235	2,720
29	2.324	9.035	8.106	0.929	1.777	20,570	0.096	1.964	1.862	0.102	0.212	2,450
30	1.685	8.862	7.955	0.907	1.836	21,250	0.087	1.847	1.755	0.092	0.194	2,250
31	1.184	8.232	7.417	0.815	1.722	19,930						

cessive applications of equation 6 and Fig. 2 in order.

Assuming spillage to begin at midnight of March 9-10, the first S and q, at the end of March 10, are computed as follows:

$F = 0.110$ $S_x = 0$ $q_x = 0$

From equation 6, $S_y = q_y = 0.110$

From Fig. 2, $q_y = 0.003$ $S_y = 0.107$

Similarly for other points.

Corresponding values of Q may be obtained from the relation, $Q = q/0.0000432$, or $Q = 23{,}148\,q$.

Columns 3, 4 and 5 of Table III are thus made up as follows: The amount given in column 3 at the end of any day equals that day's F + previous column 4 — previous value given in column 5. Current columns 4 and 5 come from current column 3 and Fig. 2. The figures in column 6 of Table III are obtained by adding the adjacent q's of column 5. Column 7 converts column 6 into sec.-ft. average flow for the day, = column 6 × 11,574.

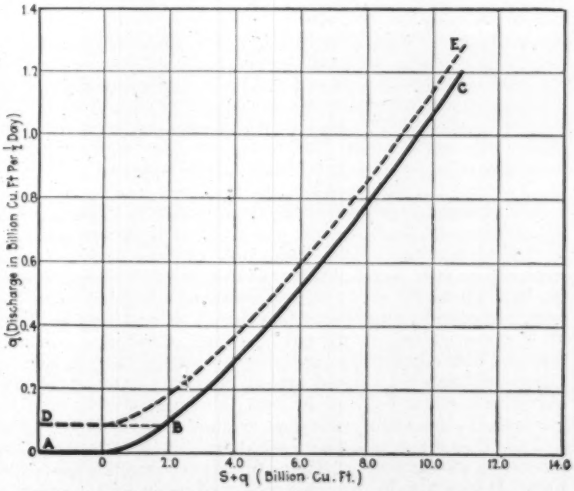


FIG. 2—SPILLWAY DISCHARGE FOR ANALYTICAL TREATMENT

The figures of column 7 are seen to check hydrograph B of Fig. 3 in the graphical cut and try method and may be used for plotting such a spillway hydrograph or a spillway mass curve, if desired. Column 5 gives the momentary rates of flow at each end of each day. The largest of these is 0.929 billion cu.ft. per half day, which is 21,500 sec.-ft., at the beginning of March 30, thus checking the peak of hydrograph B in Fig. 3. A chronological record of the spillway head, H, may be obtained from column 5 of Table III by reference to an $H - q$ curve plotted from columns H and q of Table I.

If there is a draft from the reservoir in addition to the spillage the only modification necessary in the above methods would be to make the proper changes in Table I

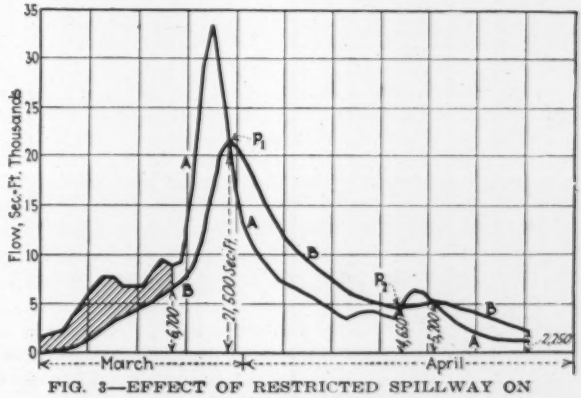


FIG. 3—EFFECT OF RESTRICTED SPILLWAY ON NATURAL FLOW

Range of curves, left to right, March 10 to Apr. 30.

and in Figs. 1 and 2. Assuming a constant draft of 2,000 sec.-ft. in addition to the spillage, it would be necessary to add 2,000 to the Q figures of Table I while the figures in columns q and $S + q$ would all be increased by $2{,}000 \times 0.0000432 = 0.0864$. These changes would result in curves DE of Figs. 1 and 2.

Further, suppose there is no draft in addition to spillage except when the spillage is less than 2,000 sec.-ft. —at which times the total discharge, including spillage,

is held at 2,000 sec.-ft. This supposition results in curves *DBC* of Figs. 1 and 2.

Assuming, as before, a brimful reservoir at midnight, March 9-10, the analytical treatment of this case would proceed as follows:

Let $F_{10} = F$ during March 10; $S_{10} = S$ at beginning of March 10; $q_{10} = q$ at beginning of March 10, etc.
Then $F_{10} = .110$; $S_{10} = 0$; $q_{10} = .086$
$(S_{11} + q_{11}) = F_{10} + S_{10} - q_{10} = .024$
from Fig. 2 $q_{11} = .086$; $S_{11} = -.062$
$(S_{12} + q_{12}) = F_{12} + S_{11} - q_{11}$
$= .147 - .062 - .086 = -.001$
from Fig. 2 $q_{12} = .086$; $S_{12} = -.087$
$(S_{13} + q_{13}) = F_{13} + S_{12} - q_{12}$
$= .164 - .087 - .086 = -.009$
$q_{13} = .086$; $S_{13} = -.095$
$(S_{14} + q_{14}) = F_{13} + S_{13} - q_{13}$
$= .191 - .095 - .086 = +.010$
$q_{14} = .086$; $S_{14} = -.076$
$(S_{15} + q_{15}) = .175$ $q_{15} = .086$ $S_{15} = .089$
$(S_{16} + q_{16}) = .442$ $q_{16} = .086$ $S_{16} = .356$
$(S_{17} + q_{17}) = .848$ $q_{17} = .086$ $S_{17} = .762$
$(S_{18} + q_{18}) = 1.331$ $q_{18} = .086$ $S_{18} = 1.245$
$(S_{19} + q_{19}) = 1.814$ $q_{19} = .090$ $S_{19} = 1.724$
$(S_{20} + q_{20}) = 2.212$ $q_{20} = .120$ $S_{20} = 2.092$
etc., etc.

indicating that spillage began during March 14, when S changed from — to +, and that the total discharge was held at 2,000 sec.-ft. until about midnight of March 18-19 when q for the first time exceeded 0.086; at which time the outlet gates would be closed and prior to which time the gate discharge is indicated by the vertical ordinates between lines *AB* and *DB* of Figs. 1 and 2.

Conclusions—It is not the purpose of this article to advocate short spillways. In view of the uncertainties of flood possibilities, liberal spillway capacity within the bounds of reason is usually wise insurance against flood damage; but this fact does not justify adding further uncertainties to the problem by using incorrect assumptions as to the flood handling capacity of a proposed spillway. Proper flood assumptions are largely a matter of judgment, aided, of course, by all available information, but the application of any particular spillway design to an assumed flood is capable of scientific analysis. To use incorrect coefficients or to ignore the retarding effect of reservoir pondage above the spillway crest is to introduce a definite error into the calculations.

Reclamation Laws Compiled

A document of unusual value is made avaiable to the public in "Federal Reclamation Laws, Annotated," just issued by the Bureau of Reclamation at Washington. It begins with some early ditch right-of-way and similar acts of Congress. Then come the famous Reclamation Act of June 17, 1902, and the whole succession of amendments and further enactments up to the adjustment act of May 25, 1926, by which many millions of debts owed by land owners on the Western Reclamation Project were remitted. The law passed on March 4 last, directing the Federal Power Commission to discontinue the issuance of permits for licenses affecting the Colorado River or its tributary, is the latest item quoted. There is appended a copy of that part of the "Code of laws of the United States of America" relating to the operations of the Bureau of Reclamation, up to Dec. 6, 1926, which represents a condensed regrouping of the substance of the prior enactments.

Obsolescence Study of an Office Building in Chicago

Steel-Frame Structure 35 Years Old Removed for Modern Building—Structurally Good but Obsolete in Economic Design

WHEN the removal or wrecking of the Woman's Temple, a 12-story steel-frame Chicago office building erected in 1890-1891, was undertaken in 1926, to permit the construction of a larger and more modern structure, arrangements were made for a careful examination of the old building during its demolition in order to determine the extent to which it had been affected by obsolescence. The old building was designed by Burnham & Root, architects, and its total cost was $987,628, with an estimated unit construction cost of 39c. per cubic foot.

The examination of the building was made by George R. Bailey, research engineer for the National Association of Building Owners and Managers. For establishing obsolescence, the following causes were listed by Earle Shultz, chairman of the association's research committee: (1) Normal growth in the business district; (2) shifting in location of the business district; (3) erection of buildings of a different type and style; (4) greater efficiency in the layout and operation of the newer types of buildings; (5) more modern and complete service given to clients in newer types of buildings; and (6) damage caused by new buildings adjacent to an old building, so cutting off the light and air of the older building as to diminish the value of its space and consequently its earning power. For this particular case, the first and sixth causes may be set aside, as there was no shift of business, in fact the site is one of the best in the business district, and there was no damage by adjacent buildings. An abstract of this report, as made public by the Chicago Association of Commerce, is given herewith.

Typical Design—The typical portion of the Temple building is taken as extending from the second floor to the tenth floor. The building was of wall-bearing construction with interior steel framing. Fabricated steel columns supported girders and beams with outer support at bearing plates and spandrel beams in the walls. The walls were solid masonry, 42 in. thick. Floors were of tile-arch construction, finished with oak flooring, or mosaic ceramic tile in corridors and elevated lobbies. Outside of the roof construction, the steel frame suffered practically no damage. The majority of the steel columns and all beams and girders were in perfect condition. In no instance did the beams show signs of either oxidation or corrosion, in spite of the fact that the top flanges came within the cinder-fill of the floor.

All structural members had been given a coat of what appeared to be lead and oil paint. It was similar in color to the maroon japan used frequently in these days as a protective coating. Much of the steel retained this paint covering and where the paint had disappeared the metal itself had been preserved in perfect condition. The fact that so much of the steel retained its paint in fair condition seems to question the economy of painting all structural members in a new building. It would appear that to paint the columns carrying hot and cold water lines, and possibly the exterior framework, would be insurance enough against depreciation.

Roof Construction—The roof of the Temple building offered one of the best examples of obsolescence in the structure. It was a gable or peak roof broken up with more than

50 dormers, which produced complications in the form of bad leaks during storms and the breaking up of top-story offices into irregular space. Although the 12th floor was one of the regular floors and received full elevator service, the effects of the roof extended as far down as the 10th floor, where the walls pitched back near the ceiling to conform to the steep roof slope. This slope was 30 deg. from the vertical and was evidently considered sufficiently steep to insure the roof against leaks.

Roof tiles were laid in a cement of some type, although this had been almost entirely washed away, and were also wired to the iron sheeting. The corroding of the wire fastening on each tile allowed this material to break away and leave a section of unprotected roof. Water worked under the tile covering and not only damaged the cement and rusted wire ties and the iron sheeting beneath, but leaked into the rooms below.

Defective Masonry—The brickwork, everything considered, was not in a good state of preservation. The appearance of the exterior veneer of face brick was good, due to the mortar joints, ⅜ to ½ in. thick and averaging 1 in. in width. The poor condition of the masonry was not due to the brick in this veneer course, nor to the craftsmanship, but to the worthless state of the mortar, which had lost most of its cohesion, so far as the brick was concerned. It had been tinted with mortar color and was very hard and brittle. The face brick was exceptionally dense on the mortar faces and offered but little grip in the first place. As soon as this mortar dried out, which might have been accelerated by laying the brick in very dry weather without wetting it down, or through some action on the part of the mortar color, there was practically no bond left between the bricks. From face bricks picked at random the mortar broke away in brittle pieces like glass.

While the walls were being wrecked it was evident that the bond between face bricks, as well as between face brick and common brick, has been destroyed. As soon as the load was taken off, a large percentage of these bricks could be removed by hand. Where any difficulty was experienced in removing them in this way, a slight leverage with a pick was sufficient to loosen four or five courses, the joints pulling apart and the bricks remaining entirely loose in their positions.

The spread foundations of steel and concrete were obsolete, not because they were of the spread type rather than concrete piers, but their obsolescence was in the construction design. Concrete was used as a bedding and a filler with compressive value, rather than as a structural material, as it is used today. These foundations were not only costly but allowed a settlement that proved destructive.

Obsolescence of Design—While obsolescence of layout is an intangible consideration, it is a great factor in the financial history of any structure. Progress in tenancy has been marked by an increased efficiency of office furniture and its arrangement, and has resulted in a diminution of the space required in which to transact business. Modern tenancy demands a different column spacing to facilitate economical division of office units. Old buildings do not lend themselves to modern subdivision without the sacrifice of considerable space.

This old style column spacing diminishes revenue and represents obsolescence. The major instances of construction obsolescence lay in the thick walls and floors, which used a great amount of space. With modern construction, there would have been at least 1,000 sq.ft. of additional rentable area on each typical floor. This represents 8,000 sq.ft., which at $4 per square foot amounts to $32,000 per year.

Cubic Valuation—To attempt to put in figures this obsolescence of construction, the only premise on which to base the computations would be that of a unit cubic-foot cost. This premise does not actually hold in all cases, but for the present consideration, where added height is reflected in wall construction over the entire perimeter of the building, it is not so far out of line but that figures reasonably representative of the actual cost may be obtained through its application.

The thickness of the floors being 21 in., meant that 64 in. more vertical height of construction was necessary than would have been needed had the modern 13-in. floor been in vogue. This extra height required 74,000 cu.ft. At that time the construction cost was 39c. per cubic foot. The added investment, therefore, was $28,860, and this amount should be subject to the carrying charge items of interest, depreciation and taxes, or at usual rates, to 10 per cent per annum. The charge due to this item of obsolete construction in the typical section of the Temple building, amounted to $2,886 per year. This figure, combined with the $32,000 additional rental which might have been obtained had the walls occupied less space, amounts to $34,886 per year, which should be assessed against the obsolescence of construction.

Modern design would have provided considerable additional space in this ground portion of the Temple. By cutting down the thickness of the walls from nearly 5 ft. to 17 in., about 700 sq.ft. might have been recovered on the mezzanine and 1,000 sq.ft. on the ground floor. This space, assuming values of $5 and $8, respectively, per square foot, represents an increase in annual income of $11,500. Again the extra thickness in the floor construction represented additional volume, amounting to 23,000 cu.ft. With a unit construction cost of 39c., the annual charge of 10 per cent against the cost of this extra construction amounts to $897. The charge against obsolescence of construction design for this portion of the building therefore was $12,397 per year.

Summarizing the annual charges to be placed against obsolescence of construction design, the figures for the three portions of the building are: Typical portion, $34,886; upper portion, $6,100; ground portion, $12,397; total $53,383. This total represents approximately what might have been received in addition to the actual gross income, had the construction design been modern rather than the design of 35 years ago, plus the 10 per cent charge customarily made in such estimates, against the investment represented by the extra amount of construction. The charge cannot be explained away on the basis that no allowance should be made for mistakes in the original design, for these examples of thick floors and walls were not mistakes. Such design was the latest at the time the structure was built.

Obsolescence and Depreciation — In maintaining book values for office-building investments it has been a common practice to consider depreciation as running from full-value at the time of the original investment to no-value at the end of a specific period of time. The study of the Temple building indicates that the period of fifty years, commonly assumed for the life of an office building, is too great. Also, as the cost of wrecking amounted to just less than 10 per cent of the structure's original cost, the limits of full value and no value seem to be erroneous. The establishment of a fund to replace the building at the end of its useful life would have had to be based upon a depreciation extending from full value, to a negative value of $95,000 (the cost of wrecking in addition to all salvage). Spread over a period of 34 years this represents 3.2 per cent per year. Considering that the Temple was well built and modern for its time, and that it experienced no obsolescense of location, this figure of 3.2 per cent is a minimum allowance for office buildings.

Conclusions—A review of the various major items of construction in connection with the Temple building reveals the fact that obsolescence was very much in evidence in connection with all of them. From roof to foundation the structure represented obsolete design. Should the same given amount of space have to be provided today, the modern building would differ in every respect from the Temple, built 35 years ago. The interior steel framing, the masonry walls and the tile arch floors all would be different. Thus it is evident that even some of the basic principles of construction have changed in the relatively short period between the year 1892 and the present time. We have no assurance or reason to feel that these principles will not improve again in the coming 35 years of office building construction.

World Economic Recovery Is Task Set for International Chamber

Removal of Trade Barriers Considered Imperative to Establish Industrial Reason and Economic Balance—Legislative Steps to be Urged in 41 Countries

By E. J. Mehren
Vice-President, McGraw-Hill Publishing Company, Inc.

Stockholm, Sweden, July 2, 1927

REMOVAL of the trade barriers which hamper international trade, particularly in Europe, was the dominant topic of the Fourth Congress of the International Chamber of Commerce which closed here today. The enthusiasm with which the various delegations, from 41 countries, supported the recommendations and thus approved the conclusions of the International Economic Conference at Geneva is virtually a pledge that they will go home with the intention of impressing on their ministries the need of legislative steps to remove the barriers, and to remove them because such removal will be to the best interest of their own respective countries. Thus the Chamber and its national committees become the driving force behind the Geneva recommendations. The Congress also discussed a dozen reports on various phases of international trade, the reports being the result of long work by committees of experts representing many countries. Alberto Pirelli, of Milan, Italy, was elected president of the Chamber for the next two years, and Amsterdam selected for the next meeting in 1929.

Trade Barriers—Before taking up the action on trade barriers it should be noted that it was not aimed particularly at the United States tariff wall; in fact, the chief difficulties for Europe are the European trade barriers, including 11,000 km. of tariff walls that have been erected since the war.

To clear up the meaning of the term barrier, the committee, at Owen D. Young's suggestion, happily prefaced its report with a definition and preamble; "Trade barriers in the international sense are those arbitrary national restraints on the free movement of goods, capital and services, which not only restrain trade and traders but limit the economical production and distribution of goods, capital and services to the detriment of the peoples affected by the restraint. They depress the standards of living. In production of all kinds there is a unit of maximum economy. In distribution there is a market of maximum economy. Any barrier which prevents the co-ordination of the two is a trade barrier in the large sense in which this Congress uses the term. Trade is not an end in itself. It is only a means to an end. The general economic welfare is its goal."

Plea for Action—The conclusions on trade barriers, practically identical with those of Geneva, favor (1) the cessation of tariff increases and the beginning of a movement in the opposite direction, (2) equal treatment of foreigners and foreign corporations engaged in trade or industry, (3) removal of obstacles to transportation, (4) elimination of prohibitions on exports and imports, (5) simplification of customs classifications, (6) unification of tariff nomenclature, (7) stabilization of customs tariffs, (8) simplification of customs formalities, (9) removal or decrease of those tariff barriers that gravely hamper trade, starting with those which were imposed to counteract the effects of disturbances arising out of the war, (10) long-term commercial treaties, (11) removal of all barriers to free movement of capital.

Finally, the Congress endorsed the conclusions on rationalization and international industrial pools (or ententes) reached at Geneva, and already published in *Engineering News-Record*, June 9, 1927, p. 951.

The Chamber then called upon its national committees to urge upon their governments the adoption and application of the Geneva and Stockholm conclusions, to make these representations before the end of September, 1927, and report the result of their action to the Chamber so that a summary of the progress achieved might then be published. In other words, an active campaign to secure the practical application of the Geneva conclusions was put under way.

The meeting on Trade Barriers was ably presided over by Norman H. Davis, one of the official American delegates to the International Economic Conference, and Dr. Karl Kotzenburg (Germany).

Salter's Great Address—Sir Arthur Salter, head of the Economic Section of the League of Nations, under whose auspices the Geneva meeting was held, made a stirring address on the relative functions of the League and the Chamber in getting action on the Geneva resolutions. The address is given on p. 140 following this general report on the convention of the Chamber.

Following Sir Arthur, Sir Alan Anderson, retiring president, added his voice in a plea for prompt and vigorous action. He said that there are in Europe 5,000,000 out of work, and 20,000,000 more under-employed, who, stood side by side, would make a line 11,000 miles long, the distance from England to Australia. It was a queue of wretchedness, of sickly children, of suffering mothers. How soon would the delegates take action and get results at home? He begged them to keep their eyes on that 11,000-mile queue of wretchedness and press on quickly, aggressively, to bring it relief.

Additional Subjects—On the matter of uniform regulations on bills of exchange and checks the Chamber endorsed the action of its committee in preparing a draft of rules for the unification of the Latin and Germanic systems. The aim is to have only two systems: one, that of the United States and Great Britain, and the other what may be called the "Continental." The draft does not affect the American and British—or Anglo-Saxon—system. The Chamber also endorsed the calling of an

international conference on the subject, to function as a continuation of the similar Hague conferences of 1910 and 1912.

The Committee on Export Commercial Credits (commercial letters of credit) brought in a provisional draft for standardization of practice (on which eight countries, including the United States, have uniform regulations). The work received general approval and the committee was directed to continue its work until a final draft is developed.

Double taxation, as in previous congresses of the Chamber, came in for vigorous handling, the aim being to secure the abandonment of double taxation of nationals resident abroad. The League of Nations is also working on the problem. Certain amendments were suggested to the League's draft convention, notably to secure unconditional adherence to the basic principle that "impersonal taxes should be levied at the source by the country of origin and that personal taxes should be levied by the country of domicile," of the deceased owner.

A uniform method of presenting national balances of payment is being developed by the Committee on International Settlements as a needed step in studying the great question of transfers, not only in connection with Reparations but with international debt payments and all other international settlements affecting world trade. The work of the committee, which will be of great importance in following the effects of these huge settlements upon exchange, was approved, and the committee continued under the title, Committee on International Settlements and Economic Information.

Patents and Judgments—Important recommendations made by the Committee on Protection of Industrial Property (concerned chiefly with patents and trade marks), are (1) that the sanction for the non-working of a patent, in countries where such rules are in force, be no longer forfeiture of the patent, but merely the grant of a compulsory license, (2) that registry of grantees, owners and licensees of patents be established in all countries and that documents or instruments not registered shall not be valid against third parties, (3) that all countries adopt a system of protection for inventions shown at fairs and exhibitions, (4) that national committees should urge their respective governments to ratify the decisions of the Hague Conference on patents without restriction or reserve.

Certain suggestions to guide jurists in the drawing up of rules for enforcement of foreign awards (exequatur) were approved and referred to legal international bodies. A committee on fairs and exhibitions is to be created "to conciliate the interests at stake, avoiding at the same time any undue multiplicity of such undertakings liable to throw an ever-increasing burden on those participating therein."

Transport and Communication—On transport there were a series of reports and resolutions relating to rail and air transport, and to telephony, largely under European conditions. For sea transport the general use of the rules laid down in the Brussels convention of 1922 and 1923 was strongly urged by the appropriate committee and endorsed by the Chamber.

In the work and session of the Highway Transport Committee, members of the American delegation took an active part. The Highway Committee of the American section had offered an elaborate paper on highway transport, dealing with the principles of highway finance, administration and control in the United States and discussing the relation of highways to other forms of transport. At the highway session, Roy D. Chapin, chairman of the board of the Hudson Motor Car Co., presided and John N. Willys, president of the Willys-Overland Co., read an excellent paper on the development of highway finance practice in the United States. Following the meeting, Mr. Chapin entertained the delegates at luncheon, after which a number of films showing highway transport in America were shown. At the closing session, the following resolutions, submitted by the Highway Committee, were adopted:

Recognizing that motor traffic, which was once a luxury, has now become essential to the efficiency of a progressive country, the Congress recommends:

(a) That special taxes levied on the motor vehicle itself and/or on the motor fuel should be based on highway use, devoted to highway purposes, collected and expended under centralized state control.

(b) That highways should be developed to suit modern traffic and that the cost should be distributed in relation to the benefits derived.

(c) That taxes should be such that they will not check the economic use of the motor vehicle.

(d) That where it is necessary to authorize constructors of a special road to charge toll for its use, the state should retain the right on payment of compensation to purchase or control the road.

(e) That city planning should provide for a free flow of traffic and proper facilities for garaging vehicles.

(f) That every precautionary measure should be taken for greater safety on streets and highways, including education of drivers, of pedestrians and particularly of children.

Representation—Delegates numbering 852 were present from 41 countries, forming in all an exceptionally able group. The American delegation, with 162 accredited delegates, was second largest in number and in quality compared well with other groups. Germany sent the largest delegation, about 180, the explanation of the large attendance being the proximity of Germany, her close business connections with Sweden, and the intensity of her interest in the work of the Chamber. The Germans came into the Chamber since the Brussels meeting of 1925, so that this was their first meeting.

New President—Alberto Pirelli, the new president, is head of a large corporation, the Pirelli Co., of Milan, Italy, which makes a great variety of rubber goods, including automobile tires, and is a large manufacturer of rubber insulated electric cable. Its interests include rubber plantations in the Far East, and factories in Italy, Great Britain, Spain and the Argentine. His business interests have made him a student of international trade and finance.

Signor Pirelli was a member of the Italian delegations at the Cannes and Genoa conferences, a member of the Dawes Committee, and accompanied Signor Volpi, the Italian minister of finance, to America in connection with the settlement of Italy's war debt to the United States. In May he was a member of the Italian delegation to the International Economic Conference at Geneva. He sits on the Economic Council of the League of Nations, not as a government official but in his private capacity as a leading manufacturer. He is chairman of the Italian National Committee of the International Chamber of Commerce, member of the former Committee on Economic Restoration and chairman of the Committee on International Settlements.

Among Those Present—Among the American delegates present were: Owen D. Young, chairman of the Board, General Electric Co., and chairman of the American delegation; Col. Hugh L. Cooper, New York; John A. Edgerton, president, National Association of Manufacturers; W. W. Freeman, vice-president, Columbia Gas & Electric Co., Cincinnati; Philip H. Gadsden, vice-president, United Gas Improvement Co., Philadelphia; Carl E. Grunsky, San Francisco; William C. Redfield, former U. S. Secretary of Commerce, Brooklyn; Alfred Reeves, general manager, National Automobile Chamber of Commerce, New York; E. W. Ryberg, Salt Lake City, delegate from the Associated General Contractors of America; F. W. Walker, president, Associated Tile Manufacturers, Beaver Falls, Pa.; Windsor White, chairman of board, White Motor Co., Cleveland.

How to Get Practical Results from World Economic Conference

Extracts from address of Sir Arthur Salter, Head of Economic Section, League of Nations, before Stockholm Congress, International Chamber of Commerce, July 1, 1927

OUR TASK (in connection with the world's economic recovery) and in particular the task of this International Chamber of Commerce and of the forces and institutions which it represents, is at its beginning. The first stage—that of securing unanimous agreement from the conference of Geneva on sufficiently drastic, far-reaching and effective resolutions—has been accomplished with a success which has exceeded the most sanguine hopes of those who initiated the Conference. The second stage, and perhaps the more difficult, is that of securing the adoption, and application in practice to commercial policies, of the resolutions.

The nature of the task which lies ahead of us is perhaps most clearly shown by recalling the main substance of what the Conference advised. I will confine myself to the most vital of the resolutions on Commerce. The central theme of the conference was that trade barriers, and in particular tariffs, are too *high; too complex;* and *too frequently changed.* The recommendation on which it places most emphasis is that *they should be reduced;* should be *simplified and unified;* and should be made *more stable.* Let us glance in turn at each of these three problems.

Height of Barriers—As to the height, the conference starts with four declarations: That the present high tariffs have a harmful effect on trade and production; that substantial improvement in economic conditions can be obtained by increased facilities for trade and commerce; that tariffs, though within the sovereign jurisdiction of the different states, are not a matter of purely domestic interest; and lastly that some of the causes which have resulted in increased tariffs (such as currency fluctuations) have now largely disappeared, while others are diminishing. In these conditions, the conference categorically declares that "the time has come to put an end to the increase in tariffs and to move in the opposite direction." It suggests four lines of action; (1) Independent action by the several states to remove or diminish tariff barriers; (2) concerted action through commercial treaties; (3) the abolition of the practice of imposing bargaining tariffs (*tariffs de combat*) in advance of negotiations; and (4) an examination by the Economic Organization of the League, in consultation with such organizations as this Chamber, and with the governments, as to the best methods of securing further action to the same end.

Simplification—As to simplification and unification, the conference asks the League to establish the appropriate procedure, while suggesting the following principles: that there should be a systematic customs nomenclature under a plan covering all classes of goods; but that a priority should be established among the various groups of commodities, a beginning being made with those classes for which a common nomenclature can be most readily introduced; that not only governments but the producing and commercial organizations should be asked to co-operate at every stage; that the common nomenclature, as worked out from time to time, should be made effective by bilateral or plurilateral conventions; that further simplification and merging of groups within the standard system of sub-division should be contemplated; and that in order to insure the execution of engagements the League should propose measures of publicity, information and friendly settlement or arbitration.

Stability—As to the third desideratum, stability in tariffs, the Conference declared that "a decisive step on the road to world reconstruction would undoubtedly be taken if the system of long term treaties securing equality of treatment were restored." And in this connection I may remark that whereas, before the war, commercial agreements normally had a duration of ten or twelve years, no less than 153 out of 180 post-war agreements recently examined were terminable within the year.

This then is the unanimous advice of what is perhaps the most authoritative body of experts that has ever met to discuss economic policies. I come to the two crucial questions. What are the chances that this advice will be adopted and applied in practice? How is this result to be secured?

Will Advice Be Applied?—The difficulties are only too obvious. At every vital point the decisions of governments are required, decisions to change policies on which they have embarked, administrative systems and methods which they are working. All the trade barriers which the Conference wishes to remove are buttressed both by fallacies and by vested interests; and some by what is, on a short view, a real national advantage. The obstacles to reform are greater than those which retarded the application of the financial recommendations of Brussels; and the direct motive power is in some respects weaker and less concentrated. The financial recommendations of 1920 required separate action by each state, in what was obviously its own direct interest. The economic recommendations of 1927 require, in large part, concerted, or at least general, action, in the interest of a general prosperity in which each country will enjoy a share, but a share not directly proportionate to its own action.

Happily there are powerful considerations on the other side. In the first place the conference brought out with great force and clearness the fact that the worst abuses which it condemned had arisen through causes which have now disappeared or are diminishing. As the causes are disappearing, it is at least easier to remove their effects. Stronger as a ground for hope perhaps is the fact that the conference revealed an already existing feeling, of much greater force and wider range than had been suspected, that the process of increasing barriers had gone too far and must be reversed. The conference could hardly have improvised or initiated such a movement; but by developing it, expressing it, and adding the consciousness of collective support it has given it an immense increase of strength. Third, we have the great collective influence of the members of the conference and of all those institutions, like the Chamber, that have collaborated with it. One hundred ninety-four members, attended by 157 experts, appointed by governments and representing every kind of qualification and every shade of responsible opinion, have spoken unanimously and categorically and it is difficult to believe that their advice can be disregarded. Certainly the members themselves—and no men could be better judges of the difficulties—speak in terms which suggest not only hope but confidence. They look forward to the "beginning of a new era," they anticipate that "international commerce will successively overcome all obstacles in its path that unduly hamper it."

Direction of Efforts—I come now to the most important question of all, how must effort be directed, to secure the desired result? There is no simple answer. But one thing is clear. International organizations—the Chamber and the League—may do much. But the greater part of the work

is likely to be and must be national. Members of the Chamber may do a great deal in international conference and committee, but they can do even more in mobilizing the forces in their own countries and modifying the policies of their own governments.

Probably the most urgent and important thing at present is that governments should definitely adopt the recommendations of the conference, and declare their intention to make their policies conform to them. We have already had a splendid lead. Within a few days of the conference, the Belgian government declared that it gave its full adhesion to the resolutions, and was prepared at once to come to an understanding with other countries on the lines laid down by the conference. M. Vandervelde followed this up by stating to the council of the League that for an exporting country like Belgium the adoption of the recommendations was a matter of life and death, and that for such a country political independence was conditional upon a recognition of economic interdependence. M. Benes followed with a formal declaration that the Czechoslovakia government also adhered to the resolutions and intended to develop its policy in conformity with the principles which they embodied. Herr Stresemann then declared that the German government gave as full and unqualified an approval as the Belgian government, and had just taken a formal decision concurring in the conclusions and declaring itself ready to co-operate energetically in giving effect to them. I am circulating to all members a full report of the very remarkable declarations made both by these and other countries at the council of the League. Nothing could be so useful for our future work as a series of formal decisions and declarations, similar to those which I have quoted, from other countries. They would give a momentum to the movement which would be irresistible. They would determine the character, and accelerate the progress, in all the more technical and detailed work which very soon must follow.

Each Country's Duty—To secure such results, those here present can play a part of the utmost importance. It means mobilizing every kind of appropriate force in each country; working through the press, through meetings, and by every method which can move public opinion and governmental action. I venture to suggest that this is more than an opportunity, that it is also a duty. M. Themis, in his concluding speech, reminded the members of the Conference that in voting for the resolutions they had each undertaken a personal, moral obligation "to do all in their power to disseminate, to defend and to secure the triumph of the tasks they had formally proclaimed." Herr Stresemann, in addressing the council as rapporteur a fortnight ago said he was sure that the members of the council, which had convened the conference, would feel an equally strong moral engagement.

The need for action in each country is at once the most urgent, the most difficult and the most important part of the task that lies ahead. Detailed execution will go as far as, and no further than, national policies allow it; international action can gather the harvest, as it sowed the seed, but it can only help here and there in the intermediate work.

At the same time there is much that can, and must, be done by international organizations. The Economic Committee of the League is meeting in a few days to consider a plan for the tariff questions and to study in particular how to organize the work on customs nomenclature; and in September the council has announced its intention of considering changes in the constitution of the League's economic organization. If, however, you will not consider it an impertinence, I should like now to suggest, in the barest outline, what this Chamber and its members can do.

(1) Whether as individuals or as organizations, the members, each in his own country, in conjunction with the members of the Economic Conference, with the national chambers of commerce and with the national committees and all other persons and institutions that can be used for the purpose in the same country, can arouse and maintain public opinion; can secure that the recommendations of the Economic Conference are proclaimed and debated in public meetings and in parliament; can assist their governments to adopt the policy of the conference and to make declarations similar to those made by Belgium, Germany and Czechoslovakia; and can secure that actual commercial and economic policy is modified accordingly.

(2) The Chamber, here in Stockholm and through its central council, can appoint special standing committees for each of the main tasks, including for example one on customs nomenclature, and one on general tariff and commercial policy questions. It would be the task of these committees to organize efforts and work both internationally through appropriate sub-committees, through special experts, through trade committees, and through the national committees of the Chamber, and in close contact with the League.

(3) At this conference at Stockholm members of the same or closely associated trades and industries of different countries might meet and begin discussions as to the best methods by which trade barriers can be removed or reduced in the sphere with which they are specially concerned. So far as such discussions contemplate anything in the nature of international industrial agreement, they would doubtless be guided by the principles laid down in the report of the Economic Conference. I suggest discussions between closely associated industries, including, for example, a primary industry and the industry which uses its products as its own raw materials, and between similar industries of different countries, because such discussions are favorable to a genuine attempt to remove trade barriers in the particular economic sphere which they cover.

(4) The national committees of the Chamber, which did much valuable work in preparing the resolutions of the Economic Conference, might meet with the definite purpose of organizing the efforts within each country to secure their adoption. In this case I suggest the committees should meet as a whole, including all trades and industries, and should divide their work rather by subject than by industry; for group meetings of a particular industry within a single country are not the most favorable means of securing tariff reductions. The work of such national committees, and their sub-committees, would doubtless be encouraged and to some extent guided by the international committees of the Chamber which I have suggested above.

(5) The International Chamber will doubtless take all the necessary measures to collaborate with the League both by the methods now in operation and other desirable ones.

Results Vital to World—This, then, in the barest outline is the nature of our task and the way in which we may accomplish it. Let me in conclusion recall its vital importance not only to all the interests here represented but to the world as a whole. We have in the resolutions of the Economic Conference the unanimous advice of the most authoritative body of world experts that has ever met as to the direction in which the economic policies of the world ought to develop. We have their considered opinion that the adoption of what they recommend will substantially increase the prosperity of the world. We have their equally authoritative and unanimous opinion that not only the increased prosperity but the maintenance of the peace of the world depends largely upon economic policies being transformed as they desire; for the evils they wish to remove cause not only loss but friction, they are obstacles not only to the growth of trade but to international good will. Surely, if the unanimous advice of a conference so appointed and so qualified is disregarded, we shall begin to despair, not only of one conference, but of international conferences in general; despair indeed of reason itself, or at least of collective reason, as the guide to the government of the world.

In this tremendous, and still doubtful, issue may I express my conviction that this International Chamber, its members acting individually and collectively, the great institutions which they represent and the powerful forces which they influence, can play an immense and perhaps a decisive part. With your whole-hearted aid, but scarcely I think without, we may hope for the realization of what the members of the Conference declared to be their unanimous desire that we shall now see the "beginning of a new era, during which international commerce will successively overcome all obstacles in its path that unduly hamper it, and resume that general upward movement, which is at once a sign of the world's economic health and the necessary condition for the development of civilization."

The Second of a Series on
HIGHWAY MAINTENANCE

State Maintenance Independent of Counties

By W. F. Rosenwald
Maintenance Engineer, Minnesota Department of Highways, St. Paul, Minn.

MINNESOTA maintains its 7,000-mile trunk highway system under direct state control. This plan has been in effect since May, 1921, at which time the system was established by legislative action.

Previous to 1921, the main roads were included in the state-aid system, which was constructed and maintained jointly by the counties and the state. The counties, through the county commissioners and county highway engineers, then carried out all of the work, toward which the state paid certain amounts of state aid, and to which was also added such federal aid as was then available. This plan worked out very well and had many advantages, but it was rather obvious that it did not provide for an adequate state system of primary roads, and for that reason the change was made whereby the state financed and took over the state-wide system under direct control.

Organization for Maintenance—The organization that took over the maintenance work was the maintenance subdivision of the state highway department, under which the entire trunk highway and state aid road program was being directed. Reporting to the commissioner of highways and the chief engineer, the maintenance engineer was placed in direct charge of the work. Under him the state was divided into sixteen maintenance districts, each placed in charge of a maintenance superintendent. Each maintenance superintendent (a trained highway engineer) was given charge of all maintenance operations in his district, and reported to the maintenance engineer. For special work such as bridge maintenance, surface treatments, etc., special engineers were assigned on a statewide plan until the districts could handle such work economically.

To co-ordinate maintenance and construction work, the division engineers, who have general charge of all operations in their respective divisions, also have general supervision over maintenance. There are eight divisions in the state, each covering two maintenance districts. The division engineers report to the chief engineer on such maintenance matters as might affect construction and other road activities, and in this manner the entire road program is properly balanced and co-ordinated.

This plan of control is now in effect for its sixth year and is functioning satisfactorily. No changes have been made since it was started, and none are contemplated. The accompanying state map shows the territory covered by each maintenance district as compared to the individual counties. It also shows the general control divisions covered by each division engineer.

Advantages of Direct State Maintenance—The advantages that direct control seems to have are:

(1) It leaves with the counties the problem of taking care of a secondary system of highways only, which fits in well with the experience, policies and political reactions of county authorities. If such a secondary system, which is as a matter of fact the feeder system to the main roads, and a complete service system to the smaller municipalities within a county, is properly constructed, maintained and administrated, the county authorities find that they have all they can attend to without attempting to extend their authority over the wider problem of the state-wide system.

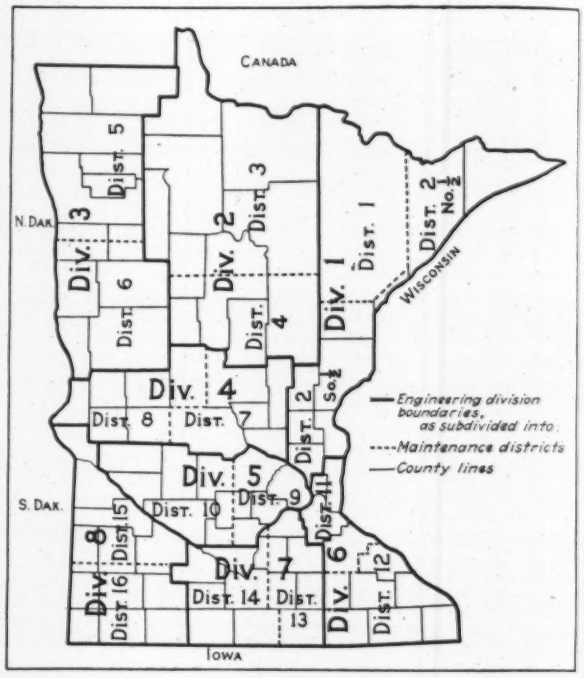


FIG. 1—SECTIONAL SUBDIVISIONS FOR TRUNK HIGHWAY MAINTENANCE CONTROL IN MINNESOTA

(2) As far as the state is concerned, the administration of a state-wide system through the counties meets with the difficulty of trying to educate county officials and a constantly changing personnel, to the viewpoint of handling the state system from a statewide viewpoint. Since the county officials justly and naturally see the problem from the local standpoint and from the reactions of their constituents, it requires interminable effort to educate them and broaden their viewpoint to the greater problem. Progress is slow and in some cases almost impossible, due to the constantly changing personnel of the numerous administrators when the system is being handled through county organizations.

Direct control permits the use of many policies and methods of execution that cannot be carried out through the complex scheme of county control, and the results obtained through direct control are less modified from the original policies and plans inaugurated than they are when carried out through a complicated organization of administrators, each of whom naturally injects a personal factor into the work.

The first noticeable improvement is greater uniformity.

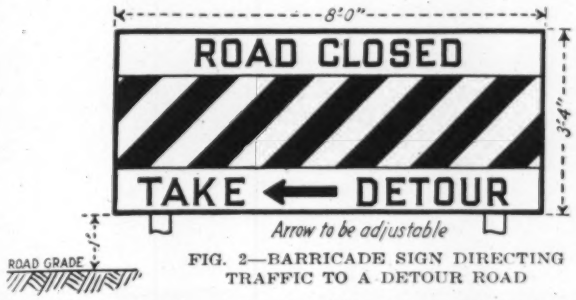


FIG. 2—BARRICADE SIGN DIRECTING TRAFFIC TO A DETOUR ROAD

This is natural, due to the fact that the work is carried out through a small number of executives. In this state, where maintenance was previously carried out through 85 county boards and county highway engineers, it is now being carried out through 16 district maintenance superintendents. Quicker action is possible, due to the fact that as soon as a policy has been decided on it is forwarded to the district men and immediately put into effect, whereas through the county scheme such matters must first be referred to the county boards and then carried out through the various county organizations.

Under the state-wide plan of organization for maintaining the highways the highways can be built up to suit the traffic and main road conditions particularly. These main highways carry a much greater traffic than do the secondary roads, and it is therefore essential that equipment and personnel be such that it is particularly and economically adaptable to such work. In the previous scheme it was very often a fact that the county organization when built up to take care of the trunk highway traffic was uneconomical and wasteful when adapted to secondary roads, and it was also true that if the county organization was most economical for the secondary roads, it was not sufficient to take care of the trunk road requirements, and there was a constant effort being expended to equalize and adjust plans, methods, etc.

Special crews to carry out and solve special problems peculiar to heavy trunk highway traffic are very often necessary, and the operations of such crews in order to be economical both as to personnel and equipment, cover a wide range of territory including several counties. This can be very easily done under state control, but it meets with difficulties under the county unit system. It is cumbersome to change equipment from one county to another and it proves expensive if each county tries to equip itself fully to take care of these smaller special problems.

The marking of trunk highways has always been a difficult matter to have properly executed in the field. Every man sent out, in spite of minute and thorough instructions and regulations, is bound to inject his personal equation into the erection and arrangement of signs, and in a statewide system these variations are only between districts, where even then it is found difficult to reduce the variation under direct control. Under indirect control it would be correspondingly more difficult to eliminate the lack of uniformity.

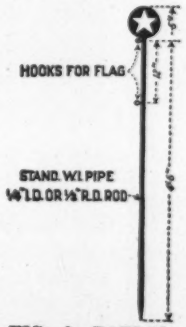


FIG. 3—PATROLMAN'S STAFF
Identification staff carried and displayed by maintenance patrolman.

The matter of local politics, too, is something that cannot be overlooked, due to the fact that the road problem is a political problem. The building and maintaining of roads is the result of a demand on the part of the people for a certain kind of service, and they make this demand felt through their elective officials, who in turn formulate the general policies and regulations under which the road work is to be carried out. Where the state system is in effect, legislators meet once every two years and during the two-year interval the work can be carried out without the injection of small disturbances that are often felt through county boards which hold meetings once every month and sometimes oftener.

Progress in road design, construction and maintenance is a constant uphill fight and plans must be put into effect and carried out sometimes against the strenuous objection of the people who cannot visualize the greater problem. But after the plan has been put into effect and after the public is able to see what is being accomplished, the objection subsides and approval is usually the result. Under the state scheme, these minor storms can be ignored, and the work can go forward with the expectation that the plan will prove its worth and no serious results will obtain.

The statewide scheme also very likely permits the reduction of equipment requirements due to the fact that major units of equipment can be used as they are now being used in Minnesota through an average area of 12 counties. This applies particularly to big tractors, pavement repair equipment, gravel surface treatment equipment, etc., useful on trunk but not on secondary roads.

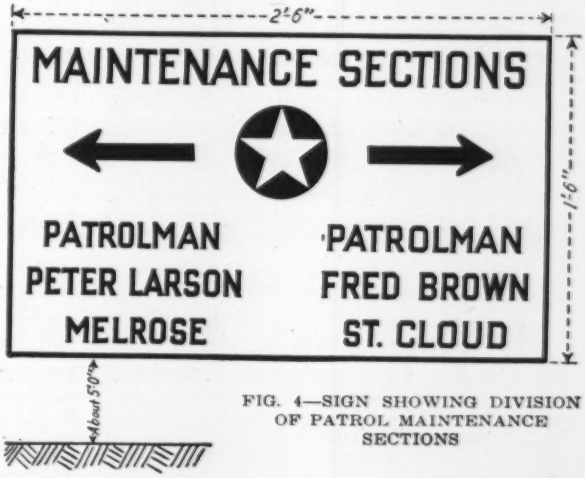


FIG. 4—SIGN SHOWING DIVISION OF PATROL MAINTENANCE SECTIONS

By isolating the administration of a trunk system from a secondary system of roads, which is the greater problem of a county, the confusion of policy is eliminated. The state is interested primarily in carrying the greater amount of traffic over a limited mileage of roads reaching out to all parts of the state, and serving major points within the state and bringing the road system to points at the state line where it can pass on conveniently to adjoining states. The counties are interested in serving all of the communities within the county, and, as stated before, the roads serving all the communities in the county carry, on the average, much less traffic. Their problems are different and the political demands are different, and where an official is trying to meet these conditions, together with the conditions which have to be met on a limited mileage of heavy traveled roads, it is easy to see that the policy would naturally need to be of a dual nature and perhaps rather hard to carry out.

The scheme of the statewide system of main highways administrated by state authority and the plan of the secondary system administrated by the county authorities isolate the two problems and permit, as stated before, the separation of these policies and the placing of them in administrative hands, peculiarly trained and adapted to the carrying out of their respective purposes.

Conclusion—Minnesota has gone through the experience of handling its maintenance, both through the counties and through the state organization, and it is felt that the state organization is by far the better plan. When the county organization functions within the sphere of activities to which it is best adapted, it functions very efficiently and in some cases even more efficiently than does the state. But when the county organization gets out of its sphere of activities, factors are introduced that make that plan less efficient than the statewide plan.

Under the Minnesota scheme it is believed that the county officials in carrying out the state-aid and county road programs have something to contend with that will call upon their full time and capacity. The state, in carrying out its trunk highway program, has certainly realized that it has all it can do properly.

[*The next article will be "Maintenance by Contract" by G. F. Schlesinger, director of highways and public works, Ohio.*]

Cement Linings in Irrigation Canals Economic Success

Experience with Imperial Valley System Shows Need for Care in Guniting and for Expansion Joints in Small Canals

THE following notes have been compiled to answer inquiries about the extent and present condition of linings placed some years ago in canals of the Imperial Irrigation District in California. The information was furnished by H. M. Rouse, engineer, Colorado River Land Co., who was formerly irrigation engineer with the Imperial Irrigation District.

Generally speaking, linings in the canals of the Imperial Valley system have been put in only where needed for protection from high velocities or excessive seepage or both. There has been no general program of lining old earth canals to reduce seepage and maintenance costs. A general lining program at this time is believed inadvisable because if Boulder Canyon dam is constructed that would largely eliminate the silt problem.

Lined sections were required in original construction on Eucalyptus and Dahlia wasteways (see accompanying table) where velocities exceed 10 ft. per second. The lining of No. 9 lateral was part of a construction project and was to prevent excessive seepage in a new high fill, reduce size of the fill required, and prevent leaks due to burrowing animals, as well as to eliminate maintenance costs. Seepage, dredging maintenance cost and danger of breaks due to burrowing animals were the reasons for lining the old Birch canal. Lined canals of the system not shown in the tabulation consist chiefly of small canals in the north end of the valley and lined transitions.

Birch and No. 9 lateral canals afford a good example of the reduction in maintenance costs that results when lined canals have sufficient velocity to carry the sand and silt content of the irrigation water on to turnouts and so to the land, or to a sluice basin or sluice outlet where surplus water can be used to move the material into the deep river gorges of the valley.

In the case of Birch canal the maintenance costs were reduced from about $500 per mile per year to $15 per mile per year, by lining which cost, roughly, $8,000 per mile. The maintenance saving mentioned, which is exclusive of breaks, includes an average of one and one-half dredgings per mile per year and three-fourths of the annual brush-clearing expense, as well as the cost of patrolmen.

Sand is deposited at times in the lined portion of the Birch canal which is the upper 1½-mile stretch of a 5½-mile lateral, but a sufficient length of lined section and a sufficient head at the upper end permit increased velocities automatically developed by increased slope to scour the sand deposits. Sand which is not deposited in the lined portion, or which is scoured from it, is carried to ranch turnouts or to the unlined section where it is dredged out with practically no increased dredging expense for the unlined portion. If the remaining portion of the Birch canal were lined, all dredging and breaks in the canal would be eliminated and sand deposits could be sluiced out weekly into the deep gorge of New River.

FIG. 1—BUCKLED SECTION IN THE BIRCH CANAL
This is a typical defection of the gunite-lined canal in which no expansion joints were used.

In the case of the No. 9 lateral, there is a sluice basin at the end of the lined section where accumulated sand deposits are sluiced weekly into the deep Alamo River gorge. The saving in maintenance costs on the 2.3 miles of the lined portion is fully as great as in the case of the Birch.

No expansion joints were used in lining the Birch canal which was built in the high fill of an older canal. The top of this lining has a thin edge, no roll or coping being used; ordinary heavy chicken fence wire mesh was used as reinforcing. The job would have been of much more substantial nature if there had been a berm or coping at the top and expansion joints placed, say, 20 ft. apart. It is not believed that any additional thickness of lining in this canal would have been advantageous.

The first maintenance was done four years after construction and consisted of clearing the brush from the levees, grubbing out roots that seemed to be helping to raise the lining from the backfill or that had entered the canal through cracks. The backfill was also restored to 2 in. above the top of the lining wherever it had been lowered below the concrete by wind, pedestrians, burrowing animals, etc.

The inspection made after this four-year period

showed a very general buckling or bulging of the lining due to expansion, as shown in Fig. 1. The bucklings averaged 75 ft. apart though they were not at all regularly spaced. The typical buckle involved three vertical cracks from the top of the lining to within 1 or 1½ ft. of the bottom of the channel. The two slabs between the three cracks bulged into the canal forming a ridge roof effect with a "gable" at either end.

Usually the lower end of such gables provided an entry point for roots that not only obstructed the flow themselves but accumulated mounds of silt that decreased the canal capacity. At one point a rat hole and a gopher hole connecting through the outer slope with one of these gables permitted a small flow of water out of the canal.

The repair work done four years after construction consisted in removing the silt accumulations at the gables and taking the obstructions out of the gables themselves. It was impracticable to interrupt the service long enough to permit removing the buckled section and placing new lining. No bad effects were noted as the result of this lack of patching. The rise of the lining at points where buckling occurred varies from 1 to 4 in. and has not changed materially in the last two or three years. Shrinkage cracks were not serious though quite regularly spaced on an average of about 15 in. apart.

In contrast to the Birch canal a plastered lining 2 in. thick without expansion joints in a semi-circular ditch 18 in. deep in the same fill, but on a private ranch, is still in excellent shape after about three years of use. The reinforcement in this ditch lining is similar to the Birch but heavier. The ditch section is about 1/15 that of the Birch canal.

No. 9 lateral includes both plastered and gunite lined sections, Fig. 2. Both of these linings were made with

FIG. 2—GUNITE LINING IN LATERAL NO. 9
Note expansion cracks on north side (left) that have been filled with mastic.

and without expansion joints particularly for experimental purposes. On this job there was 9,725 lin.ft. of gunite lining with a 4-in. coping at the top. Expansion joints 25 ft. apart were put in 1,271 ft. of the gunited lining. There was also 2,500 lin.ft. of plastered lining and in 1,300 lin.ft. of this expansion joints were used. No. 20 chicken wire mesh reinforcing was used throughout. On this job the major proportion of repairs was required by that part of the gunite section which had no expansion joints.

In addition to the lack of expansion joints, the need of a higher percentage of repairs in the gunited section is attributed to the fact that "rebound" accumulated at the bottom of the section with a thin overlying coating of cement that deceived the operator by making the work appear to be of better quality than it really was. This condition necessitated a few large patches soon after construction. In the gunite lined canal where ex-

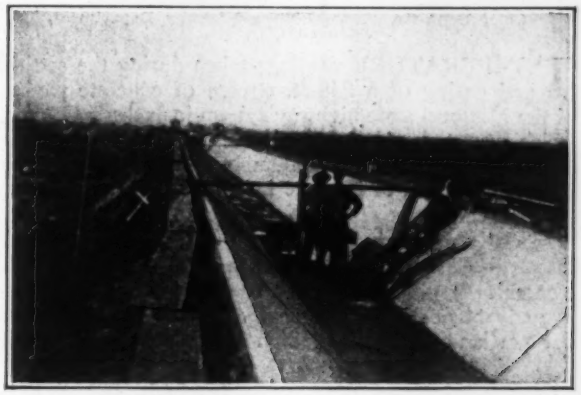


FIG. 3—TYPICAL CONSTRUCTION VIEW IN PLASTERED SECTION OF NO. 9 LATERAL
Note that this canal is built in a high fill. This section had expansion joints and coping.

pansion joints were used, closer attention was necessarily paid to the guniting because of the short runs between joints and this was probably responsible for getting good results in that section.

Separate costs were kept on all four sections and showed practically the same cost per square foot for plastered and gunite lining. The plastered lining gave a much smoother finish although it is doubtful whether any difference in the allowable freeboard should be made on this account. The first material used for filling the expansion joints would not stand the heat of the sun, especially on the north side of the canal, and a more viscous product had to be substituted.

CANALS LINED DURING CONSTRUCTION

Name of Canal	When Lined	By Whom	Gunite Lined Ft.	Plaster Lined Ft.	Base Width Ft.	Depth Ft.	Side Slopes	Thickness In.	Velocity Ft. per Sec.
Eucalyptus Wasteway	Winter 1919–1920	I. W. Co.* No. 1	2,060	.....	.....	4.5	...	...	....
Alder No. 7	Winter 1919–1920	I. W. Co.* No. 1	2,600	.....	Curved section	4.5	1:1	...	....
Birch	1920–1921	I. W. Co.* No. 1	8,200	.....	2	3.5	1:1	1	3.3
Dahlia Wasteway	1921–1922	I. W. Co.* No. 1	940	.....	12	5.5	1:1	2	12.5
No. 9 Lateral	1923–1924	Imp. Irr. Dist.†	9,725	.....	4	4.5	1:1	1	3.8
No. 9 Lateral	1923–1924	Imp. Irr. Dist.†	.....	2,500	4	4.5	1:1	1½ 1¾	3.8
Total lined.....				26,025					

* Imperial Water Co. No. 1.
† Imperial Irrigation District.

The entire 2.3 miles of this lining job was built in a high fill made by a dragline dredge. The dredging cost and resulting high cost of rough forming and soaking preliminary to the final trimming to section made costs high and not comparable to the cost of lining a canal in cut. No breaks actually resulted from shrinkage of the fill. In a few places where the shrinkage was enough to leave space underneath the lining, backfilling was done promptly to relieve this danger.

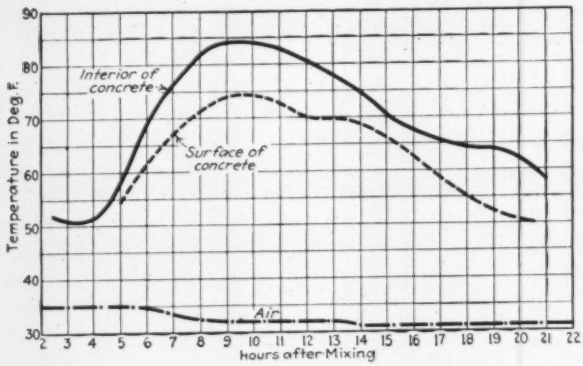
Temperatures Developed in High-Alumina Concrete

Observations Made During Construction of 258-Ft. Stretch of Missouri Highway at Freezing Air Temperatures

By T. H. Cutler
Chief Engineer, Missouri State Highway Department, Jefferson City, Mo.

TEMPERATURE readings taken during the setting and curing of a 258-ft. stretch of concrete paving of the Missouri state highway system in Jackson County, which was successfully laid under cold weather conditions by the use of high-alumina cement, showed the concrete to begin to increase in temperature about 4 hr. after mixing.

In order not to inconvenience traffic, it was desirable to construct the paving and open it to use as early as economically possible. After considering the comparative advantages and disadvantages of ordinary commercial portland cement and high-alumina cement, it was



TEMPERATURE RELATION BETWEEN CONCRETE AND AIR

decided to use the latter. The advantages favoring the use of high-alumina cement were that it could be more easily cured during cold weather and would produce high early-strength concrete, permitting the opening of the paving to traffic at an earlier date, while the main objections were the additional cost, amounting to $925 on this particular job, and the special precautions required to obtain consistently good concrete with early-hardening cement.

Traffic over this section of the highway was very heavy and as the length of the only detour was excessive, it was decided to use one-half of the road width during the construction and curing of the paving. After the first half had been constructed, traffic was carried over it and the remaining 9-ft. width of slab was constructed and cured.

Because of the fact that the work was done under cold weather conditions, every precaution was taken to utilize the advantages of the high-alumina cement. The concrete was mixed from 2½ to 3 min. in a 2-sack mixer. The temperature of the aggregate was approximately 30 deg. F. and the water 34 deg. F., with a resulting temperature of the mixed concrete of from 40 to 46 deg. F. The concrete as delivered to the subgrade had a 1½-in. slump. The finishing was done by hand. No cover was used while the pavement was curing, except on the concrete poured late in the day, and sprinkling was omitted entirely. No cover at all was necessary during the construction of the second half of the paving on account of milder temperatures which then prevailed.

Temperature readings were taken of the air and concrete at regular intervals during the curing process, particularly during the period in which the high-alumina cement was obtaining its set and the heat evolution was the greatest. A thermometer was inserted to obtain the temperature of the interior of the slab and surface readings were taken under a blanket covering the slab. The accompanying diagram shows the temperature of the air and the temperature of the concrete during the hardening period of a batch of concrete under observation. During the first 4 hr. after leaving the mixer, the temperature of the concrete dropped due to the low air temperature. After the concrete received its initial set, the temperature began to rise, even though the air temperature was near the freezing point. The surface temperature readings as recorded are probably a little higher than the actual temperature of the concrete, due to the fact that the heat evolved was confined under a blanket and not permitted to dissipate freely.

These observations indicate that the concrete generated enough heat to prevent its freezing, without protection, during the hardening period with air temperature slightly below freezing. The temperatures as observed give a general idea of the relation between the temperature of the air and the temperature of the concrete but they are not offered as establishing any definite relation applicable to all conditions.

The work was done under the direction of H. M. Brush, division engineer. R. M. Whitton, division construction engineer, and P. M. Heller, project engineer, assisted in the construction. Temperature observations were reported by V. B. Saville, division materials engineer.

Recent Slides in Panama Canal

Two slides of considerable magnitude but without serious consequences are reported in *The Panama Canal Record* of June 22, as follows: "A portion of the west bank of Gaillard Cut near Culebra loosened on June 17, and about 10,000 cu.yd. of earth and rock slid toward the canal. Further movement occurred on June 20, and as the result of both about 20,000 cu.yd. of material have slipped into the canal. The 15-yd. dipper dredge *Gamboa* has been set at removing the material from the channel. Cucaracha slide, on the other bank of the cut and directly south of Gold Hill, started to move in the night of June 19. The entire area of the slide, about 45 acres, was involved. The slide was still moving during the morning of June 22, at the rate of about ½ ft. per hour. About 90,000 cu.yd., mostly rock, have moved into the safety basin at the foot of the slide, with only 8,000 cu.yd. any interference with navigation." Later reports state that a total of 35,000 cu.yd. moved in on the west side. The Cucaracha slide stopped on June 27. During the time it was in motion, 115,000 cu.yd., mostly rock, slid into the canal; 105,000 cu.yd. of this was caught in the safety basin, so that only 10,000 cu.yd. reached the channel.

Design and Construction of Gooseneck Sewer

Reinforced-Concrete 17- to 21-Ft. Sewer to Serve 3,460 Acres in Kansas City—Inner Forms Supported on Travelers, Outer Forms Held by Bolts and Spreaders

By J. F. Brown
Office Engineer for Black & Veatch and E. M. Stayton,
Kansas City, Mo.

THE GOOSENECK storm sewer, now under construction in Kansas City, Mo., marks the culmination of the efforts of several city administrations to solve the problem of surface drainage for a considerable area in the northeasterly part of the city. The original surveys for this project were begun Aug. 1, 1917, and the rights-of-way across private property were acquired by condemnation proceedings in 1918. Owing to the high level of wartime and post-war construction costs nothing more was done on the project until January, 1921, when preliminary design studies were undertaken by the Division of Sewers, city engineer's office. Lack of a suitable plan of financing delayed the completion of contract drawings, and it was not until a bond issue was authorized, at an election held in August, 1924, that a definite and suitable plan of financing the construction program was arranged. In February, 1925, final surveys were begun, the preparation of contract drawings following immediately, and a construction contract was awarded in June, 1925.

General Description—The Gooseneck sewer is approximately 9,000 ft. long, 17 ft. in diameter at its upper end and 21 ft. at its lower end. The sewer barrel is of the three-center, hinged arch type (Fig. 4), its discharging capacity increasing from 3,320 sec.-ft. at the inlet to 5,220 sec.-ft. at the outlet. The entire structure is of reinforced concrete.

Drainage Area—A drainage area of 3,460 acres served by this storm sewer lies wholly within the city (Fig. 1). This includes 1,927 acres of residential area, 203 acres of apartments, 579 acres of industrial area, 687 acres of retail business area, 64 acres of parks and cemeteries, and 17 acres of railroad switch yards, as indicated by the present development and contemplated by the present zoning ordinance of Kansas City. In determining the percentage of impervious area in each classification the assumptions were made that all streets would be considered as paved, that all areas coming under the action of the zoning ordinance would ultimately be covered with buildings and private and public walks and drives, the areas of which would bear the same percentage relation to the total area as do the present improvements in the completely built-up portions of these zoned areas. The areas of present buildings and other improvements were determined from actual survey and from studies of the Sanborn maps. Table I shows the development classification and percentage (ultimate) of impervious area in each sub-area of the Gooseneck Creek watershed.

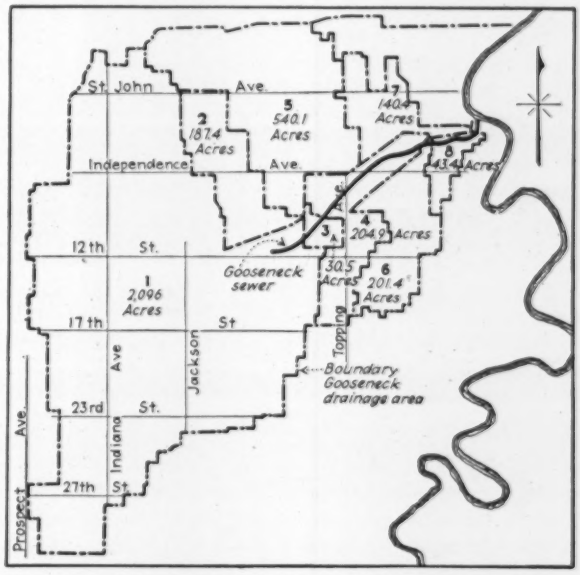


FIG. 1—SUB-DRAINAGE AREAS, GOOSENECK SEWER

Rainfall—The records of the U. S. Weather Bureau at Kansas City were studied in detail to ascertain the duration and rainfall intensities for maximum storms occurring during the period from 1898 to 1924, inclusive. The curves (Fig. 2) show this information for the most severe storms, together with curves projected from

TABLE I—CLASSIFICATION OF GOOSENECK SEWER DRAINAGE AREA

Sub-Area No.	Total Area, Acres	Classification of Areas, in Acres, and Per Cent Impervious — Residence Acres	Residence Per Cent	Apartment Acres	Apartment Per Cent	Industrial Acres	Industrial Per Cent	Business Acres	Business Per Cent	Park Acres	Park Per Cent	Weighted Average Per Cent Impervious
1	2,096.0	1,108.0	50	203.0	60	314.0	25	430.0	68	41.0	0	50.0
2	187.4	107.4	50	.....	..	20.0	25	60.0	68	.....	..	53.1
3	30.5	.....	..	.....	..	28.5	25	2.0	68	.....	..	27.8
4 (a)	143.0	72.0	50	.....	..	32.0	25	39.0	68	.....	..	42.4
4 (b)	41.4	.....	..	.....	..	41.4	25	.....	..	.....	..	25
4 (c)	19.5	.....	..	.....	..	19.5	25	.....	..	.....	..	25
5	540.0	435.1	50	.....	..	3.0	25	79.0	68	23.0	0	50.2
6 (a)	180.0	134.0	50	.....	..	12.0	25	34.0	68	.....	..	51.7
6 (b)	21.4	.....	..	.....	..	11.4	25	10.0	68	.....	..	45.0
7 (a)	78.0	61.0	50	.....	..	.....	..	17.0	68	.....	..	54.0
7 (b)	53.0	.....	..	.....	..	53.0	25	.....	..	.....	..	25.0
7 (c)	9.4	.....	..	.....	..	9.4	25	.....	..	.....	..	25.0
8 (a)	37.4	9.4	50	.....	..	12.0	25	16.0	68	.....	..	40.7
8 (b)	6.0	.....	..	.....	..	6.0	25	.....	..	.....	..	25.0
X	17.0	.....	..	.....	..	17.0	25	.....	..	.....	..	25.0
	3,460.0	1,926.9		203.0		579.2		687.0		64.0		

the formulas calculated from the actual records for each of these storms. The lower curve, *C*, was used in the design of the Gooseneck sewer, the intensity of rainfall, as shown by this curve, having been exceeded but three times during the above period.

Coefficient of Runoff—The coefficient of runoff (*C* in formula $Q = Cia$) was assumed to vary for a given area in relation to the duration of rainfall, or, in other words, the coefficient of runoff, or the percentage of rainfall running off, from a given area will increase as the storm continues. No definite information is available from which a definite formula covering the rate of variation can be derived, the values used by engineers employing the rational method in storm sewer design having been based upon the judgment and experience of the individual. Fig. 3 shows the curves used in the design of the Gooseneck sewer. Within the range of the variation in percentage of impervious area in the various sub-areas and the time of concentration used in this design the values of *C* taken from these curves agree reasonably closely with those used by engineers in other cities.

Time of Concentration—The time required for water to reach the upper end of the Gooseneck sewer from the most remote part of the drainage area, or the time of concentration, was calculated from available data pertaining to the sizes, lengths and grades of existing sewers, and the inlet concentration time as taken from Beard's curves (see *Engineering Record*, Sept. 19, 1914, p. 337), using a population basis of 35 persons per acre.

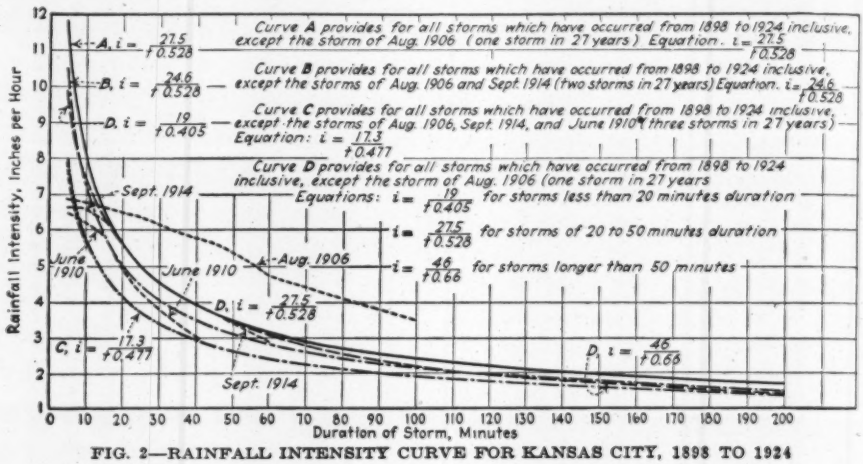

Curve A provides for all storms which have occurred from 1898 to 1924 inclusive, except the storm of Aug. 1906 (one storm in 27 years) Equation: i = 27.5 / t+0.528
Curve B provides for all storms which have occurred from 1898 to 1924 inclusive, except the storms of Aug. 1906 and Sept. 1914 (two storms in 27 years) Equation: i = 24.6 / t+0.528
Curve C provides for all storms which have occurred from 1898 to 1924 inclusive, except the storms of Aug. 1906, Sept. 1914, and June 1910 (three storms in 27 years) Equation: i = 17.3 / t+0.477
Curve D provides for all storms which have occurred from 1898 to 1924 inclusive, except the storm of Aug. 1906 (one storm in 27 years
Equations: i = 19 / t+0.405 for storms less than 20 minutes duration
i = 27.5 / t+0.528 for storms of 20 to 50 minutes duration
i = 46 / t+0.66 for storms longer than 50 minutes
A, i = 27.5 / t+0.528
B, i = 24.6 / t+0.528
D, i = 19 / t+0.405
C, i = 17.3 / t+0.477
Sept. 1914
June 1910
Aug. 1906
June 1910
D, i = 27.5 / t+0.528
Sept. 1914
D, i = 46 / t+0.66
Rainfall Intensity, Inches per Hour
Duration of Storm, Minutes

FIG. 2—RAINFALL INTENSITY CURVE FOR KANSAS CITY, 1898 TO 1924

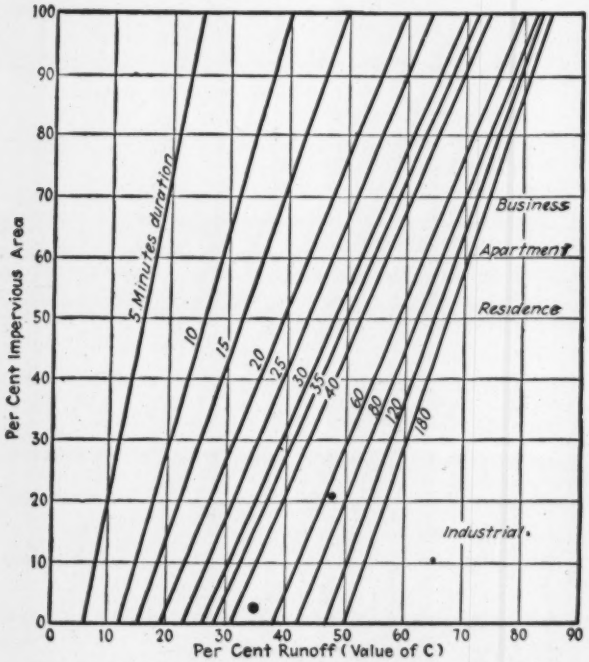


FIG. 3—RUNOFF COEFFICIENT CURVES GOOSENECK SEWER, KANSAS CITY, MO.

The entire drainage area lying above the upper end of the proposed sewer is served by combined sanitary and storm sewers, with relief overflows discharging into storm sewer trunk lines, which in turn discharge into Gooseneck Creek. Carrying capacities and velocities of flow in existing sewers were calculated by means of Kutter's formula, using values of n of 0.013 for vitrified pipe sewer and 0.015 for brick sewer. The total time of concentration was, in this manner, found to be 35 min. for the upper end of the proposed storm sewer, increasing to 42 min. at its lower end. The time of concentration for lateral sub-areas discharging into the main sewer at points along its length was taken to be 20 min., since it was found that this value gave a larger runoff than either a higher or lower value would give, while the time of concentration for the main sewer for the point of connection for each sub-area was taken as the time at the upper end plus the time of flow through the sewer from the upper end to the point in question. Table II shows the rates of runoff for which the proposed sewer was designed, and the basis data from which these rates were calculated.

Details of Design—The immediate valley of Gooseneck Creek is classified as industrial area by the zoning ordinance now in effect. The tracks of the Kansas City Terminal Ry. are located in this valley and paralleling, in general, the stream itself. The future development of this area therefore logically may be assumed to include industrial plants and factories with railroad switch tracks. The lower part of the valley is crossed by the main line tracks of the Missouri Pacific and the St. Louis & San Francisco railroads, while the sewer right-of-way itself is for a part of its length the location of a proposed boulevard now being planned by the City Park Board.

In consideration of all of these conditions the following loading assumptions were decided upon as the basis of design for the sewer structure: For that portion of the sewer to be located within the immediate valley of the Blue River, dead-load of earth fill 10 ft. above the crown of the sewer, and live-load of Cooper's E-60 on each of two tracks, 13 ft. c. to c., paralleling the sewer; for that portion of the sewer to be located within the area to be occupied by industrial plants and switch tracks, dead-load of 10 to 13 ft. of earth fill, and live-load of Cooper's E-40, single track; for that portion of the sewer to be located in future boulevard right-of-way,

dead-load of 11 to 20 ft. of earth fill, and live-load of one 15-ton truck.

The design of the sewer structure is that of a reinforced-concrete arch (Fig. 4) transmitting the vertical and horizontal loads coming upon it directly to the subgrade through the spread footings of the arch walls, with a concrete paved waterway under the arch. The concrete floor, although doweled to the arch footings, is not intended to carry any load from the arch to the subgrade.

Throughout a large part of its length the sewer is founded upon bed shale, and under this condition the possible yielding of the subsoil under the arch footings can be but slight, and consequently the theory of the design must hold. Where soft or yielding soil was encountered, at the subgrade level wooden bearing piles were driven to support the arch, and to resist horizontal movement of the earth under the footings, which, if permitted, would cause excessive upward pressure on the floor slab. The typical cross-section of the sewer structure is shown in Fig. 4. This section compares in a general way, at least, with the River des Peres sewer at St. Louis and the Shockoe Creek sewer at Richmond, Va. (see *Engineering News-Record*, Dec. 4, 1924, p. 900, and Dec. 17, 1925, p. 996).

Manholes are provided at all street crossings to provide access to the sewer, and to facilitate the installation of lateral or branch sewers. Weepholes are placed at 25-ft. intervals, just above the arch footings, to provide outlets for surface water draining into the old creek channel. Expansion joints, ¾ in. thick, of asphaltic fabric, located at 60-ft. intervals, extend through arch, footings and floor. A sanitary sewer of vitrified clay pipe parallels the new sewer, and is supported on a continuous concrete bracket on the outside of the main arch.

Construction Features—With the exception of some

TABLE II—SUB-AREAS, TIME OF CONCENTRATION, RUNOFF COEFFICIENT AND RAINFALL INTENSITY IN GOOSENECK SEWER DRAINAGE AREA

Sub-Area No.	Area in Acres (a)	Per Cent Impervions	Time of Concentration (t)	Runoff Coefficient (C)	Rainfall Intensity (I)	Runoff from Sub-area (Q)
1	2,096	50.0	35.0	0.50	3.17	3,322.0
2	187.4	53.1	0.2			
	2,283.4*	50.1	35.2	0.50	3.15	3,596.0
3	30.5	27.8	1.7			
	2,313.9*	49.9	36.9	0.50	3.10	3,586.5
4 (a)	143.0	42.4	1.05			
	2,456.9*	49.5	37.95	0.512	3.05	3,836.7
5	540.0	50.2	0.12			
	2,996.9*	49.6	38.07	0.512	3.05	4,680.0
7 (a)	78.0	54.0	.....	....	....	.....
4 (b)	41.4	25.0	.....	....	....	.....
6 (a)	180.0	51.7	1.43			
	3,296.3*	49.6	39.50	52.3	2.98	5,137.4
7 (b)	53.0	25.0	.....	....	....	.....
4 (c)	19.5	25.0	.....	....	....	.....
6 (b)	21.4	45.0	.....	....	....	.....
8 (a)	37.4	49.7	2.00			
	3,427.6*	48.6	41.50	52.0	2.92	5,204.5
7 (c)	9.4	25.0	.....	....	....	.....
8 (b)	6.0	25.0	.....	....	....	.....
X	17.0	25.0	0.67	....	....	.....
Total....	3,460.0	48.7	42.17	52.4	2.88	5,221.6

* Progressive totals.

200 ft. in tunnel, all excavation was done in open cut, using gasoline-engine-operated dragline excavators for the general excavation and clamshell excavators at points where sheeting and bracing of the trench walls were necessary. The excavated materials were placed in spoil banks along the southerly bank of the trench, leaving the northerly bank clear for concreting operations and the storage of construction materials. Because of the lack of space for spoil bank in the railroad yards, through which the sewer passes in its lower reaches, it has been necessary to use motor trucks for hauling excavated materials. Backfilling will be carried up to the level of adjacent ground, with proper allowance for settlement, and excess excavated material used for grading streets crossing the creek valley.

The contractor's scheme of operation in the building of the sewer structure includes the construction of the invert slab first, after which steel forms are set for the arch footings and the lower 3 ft. of the arch ring,

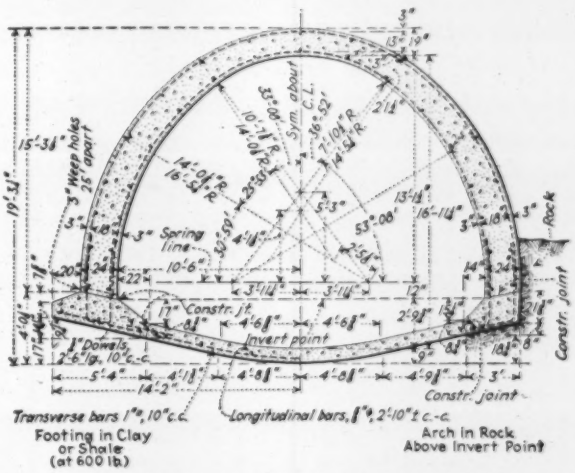


FIG. 4—TYPICAL SECTION OF 21-FT. GOOSENECK SEWER

and these concreted, leaving dowels to which the rib steel of the arch is attached. This much of the structure was completed throughout the upper 7,000 ft. of its length before the construction of the arch ring was started, in order to provide a channel for the creek. On this part of the work a construction unit consisted of two ½-yd. concrete mixers, one for the invert slab and the other for the arch footings and curb walls. These machines were moved along as the work progressed, locations being selected to permit chuting the concrete from the mixers to the forms. The frequency of moving the mixers was considerably decreased by the use of a one-ton truck chassis, upon which was mounted a ½-yd. steel hopper supported on a steel tower for hauling concrete from the main chute to the forms. With this conveyance, it was found that lengths of haul up to about 500 ft. were economical.

The construction of the arch of the sewer involves the use of steel inner forms supported on steel travelers, and steel outer forms. The inner forms are of the collapsible type, though not telescopic; the outer forms are supported from the inner forms by means of bolts and pipe spreaders (Fig. 5). The transverse reinforcing steel was delivered on the work bent to the required shapes and was set in place and tied to the dowels in the curb walls before the arch forms were moved into position. In fact the steel placing crew was kept at this work continuously and generally was several hundred feet ahead of the concreting crew. The concrete mixers were moved along the trench as the work progressed, locations for these machines being selected so as to permit chuting concrete from the mixers direct to the forms. Concrete buggies and wheelbarrows were used

for conveying concrete to points which could not be reached by chutes.

No extraordinary difficulties have been encountered in the construction of the upper 7,600 ft. of sewer, now completed; the location of the structure in the bed of the creek subjected the work to frequent temporary shutdowns due to floods, but these caused but little damage to the contractor's equipment and no damage to the structures.

The contractor then began the construction of the lower portion of the sewer. In this part of the work progress is comparatively slow, the lack of stability of the soil making necessary the use of steel sheetpiling and heavy bracing to prevent damage to railroad tracks and buildings from caving trench walls. Some 600 ft.

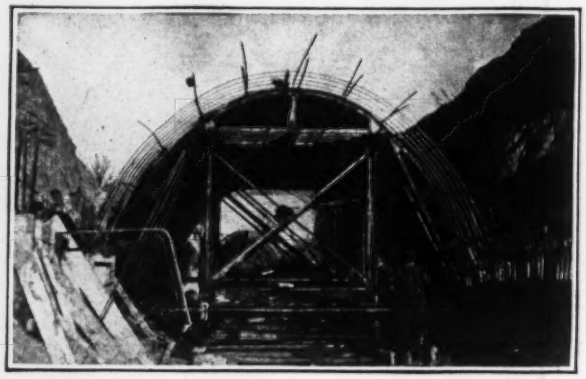


FIG. 5—ARCH STEEL FOR GOOSENECK SEWER WITH INSIDE STEEL FORM IN PLACE

of the sewer is located within the right-of-way of the St. Louis & San Francisco Ry., paralleling the main track at 32-ft. centers, trench depth being 26 to 30 ft.

The restricted space available at this point makes necessary the hauling of the excavated materials direct from the excavator, and the hauling of construction materials only as they are required for the construction of the sewer. The sewer crosses under the Frisco main track and switch lead, two Kansas City Terminal Ry. and Missouri Pacific connecting tracks, and two Missouri Pacific main tracks, all carrying heavy freight traffic. The railroad companies have constructed temporary bridges at these crossings, ahead of the excavation from the sewer, using their own bridge construction crews for this purpose.

The construction of the Gooseneck sewer was begun about Aug. 1, 1925. The contract completion date was March 1, 1927, when 91.5 per cent of the work had been completed. An extension of time to June was granted. The major quantities involved in the work included 28,630 cu.yd. of concrete in the main sewer structure; 2,330 cu.yd. of concrete in special structures; 2,162 tons of reinforcing steel; 126,600 cu.yd. of excavation; 89,000 lin.ft. of wood bearing piling, and 38,000 sq.ft. of steel sheetpiling. The total contract cost is estimated to be $1,270,000.

Black & Veatch and Edward M. Stayton, consulting engineers of Kansas City, made the plans and specifications for this project and supervised its construction. The work was done by The Torson Construction Co., of Kansas City, Kan. All tests of materials were made by the Kansas City Testing Laboratory.

Montreal South Shore Cantilever Bridge Under Construction

Foundation Work Well Advanced—Expect to Erect Large Part of Superstructure During Present Working Season

WITH the clearing of the ice and the opening of the St. Lawrence River to navigation, construction was resumed on the Montreal Harbor bridge at Montreal. The 1926 season saw a considerable progress in substructure work, and also the erection of some 1900 tons of steel. Nearly halfway through the 1927 season (the seasons are but seven months long for river work in this vicinity) the situation is as depicted on the adjoined diagram, Fig. 1.

Starting from the south, thirteen piers are complete and the trusses, floor and bracing of ten short spans are in place. Piers 14 and 15 now have most of their stone facing laid, and will be completed by the beginning of September. The pneumatic caissons for 13 and 14 were successfully sunk to solid rock last summer, using a steam plant for power and with air up to 22 lb. pressure; the bottom was dredged level before placing the steel caissons, and the excavation was in gravel until the hard shale was reached. Piers 2 to 12 are in shallow water and were built within wooden cofferdams, unwatered by pumping. Piers 15 and 16 are on piles driven in hard-packed gravel inside wooden cribs and steel-pile cofferdams. Piers 16, 17, 18 and 19 were completed during the 1925 season, as was the north abutment and the footings of piers 1 and 15.

Across the island, in the main channel, substructure work is also well advanced. The main and anchor piers on the city side were finished in 1926 and all the other river piers started. The east main pier, 24, is founded on a steel caisson 127 ft. 9 in. x 50 ft. 6 in., the fourth or fifth largest known, and with steel sides 47 ft. high. The cutting edge was landed some 50 ft. below water level and excavation was continued deeper still. Electric power was here used for all purposes, and the air pressure reached 25 lb. The stonework is now all laid,

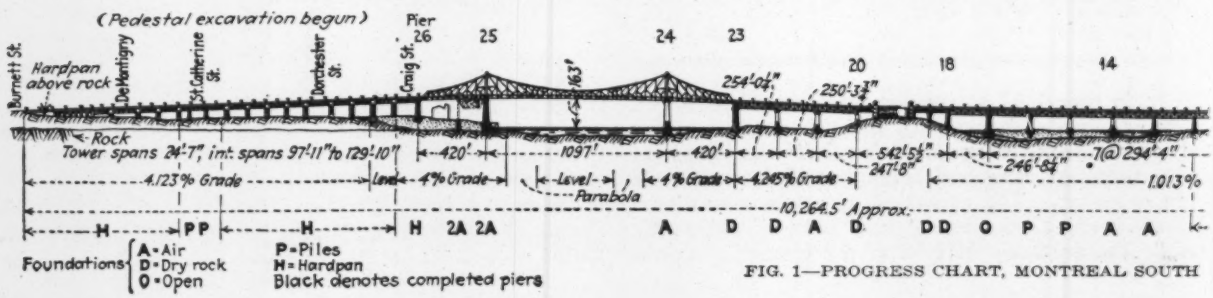


FIG. 1—PROGRESS CHART, MONTREAL SOUTH

and form construction for the upper concrete shaft is being rapidly pushed. The anchor pier, 23, is founded on the dry trap rock of Ile Ronde and was taken up high enough to receive the steel anchorage girders last November. The concrete shaft is now completely paved up to coping level. The footing of pier 22 was poured and the steel caisson for 21 was partially sunk last season, work being suspended in the late fall, in time to permit dismantling the plant before the freeze-up. The caisson has withstood the ice well, as indeed all the unfinished piers. The air plant, which was occupied elsewhere during the winter was reinstalled in May, and air work was completed by the middle of July. Stone is at present

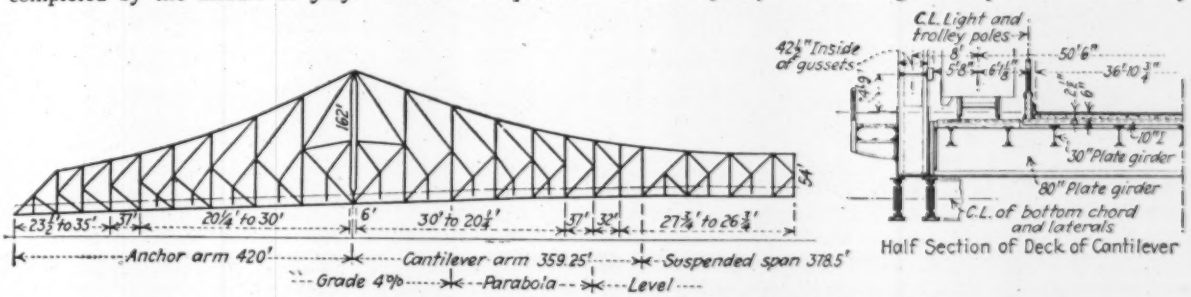


FIG. 2—HALF ELEVATION AND CROSS-SECTION OF CANTILEVER SPAN

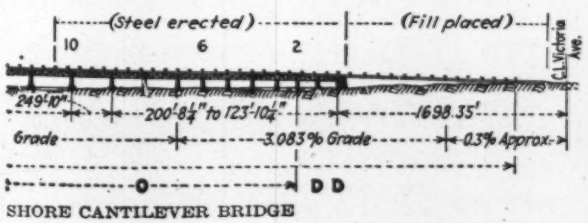
being laid on both these piers, 22 being virtually up to the last course. This limestone facing on the river piers is 42 ft. 10 in. high, extending from below lowwater to above high-ice line.

Two caissons for temporary falsework towers were sunk on the Montreal side under the site of the anchor arm, these also being taken down to rock by the pneumatic process. They were about 85 ft. deep and called for pressures up to 31 lb.

Work of This Season—It is expected that all piers and practically all pedestals, concrete arches, girders, columns and retaining walls of the north approach will be completed this season. The program for steel erection contemplates placing falsework under the deep half of the city anchor arm, and the erection of perhaps 250 ft. of main truss structure, approximately as indicated by diagram in Fig. 1. The falsework towers and trusses are now in place, the main shoes on Pier 25 are laid, and the north anchor arm bottom chords for six floor panels, with their bracing, are erected and partly riveted. The shorter spans across the south channel will be continued and main material will probably be placed as far as pier 21, including the pavilion framing. By the end of the autumn possibly some 16,000 tons of permanent metal will have been placed.

The substructure when finished will comprise about 100,000 yd. of concrete and 36,000 tons of cut stone, while the approach fills will use over 120,000 yd. of gravel.

The superstructure includes 24 spans of Warren deck-truss construction on the south side, with lengths from



SHORE CANTILEVER BRIDGE

90 to 245 ft. There are twelve of the latter, all virtually identical. Floor panels are 24 ft. 6 in. throughout this portion, making for considerable duplication in minor parts. On the north side the approach trestle includes sixteen similar truss spans, carried on towers. The main span over the navigable channel of the St. Lawrence is a 1,097-ft. cantilever span with two 420-ft. anchor arms. The clearance above high navigating water is not less than 162 ft. for a 500-ft. fairway, and the height of steel above main piers about 180. ft. The total weight of steel will reach 30,000 tons, to which the main span will contribute almost exactly half.

The capacity of the bridge is ample for modern city traffic. It provides a 37 ft. 6 in. vehicular roadway wholly unobstructed, with independent rapid-transit tracks on either side, and footwalks outside, all these lanes being adequately fenced off from one another. The clear width between outer railings is 72 ft. 5 in. Silicon steel is used largely in the principal span and the trusses of the 245-ft. spans; the remainder of the metal is special carbon steel.

The bridge is being built by the Harbor Commissioners of Montreal, Senator W. L. McDougald, president, and will be financed by a bond issue. A system of mutual aid has been worked out between the federal, provincial and municipal governments with regard to meeting possible operating deficits in the early years, but the engineers estimate that after five or six years the income will meet interest, sinking-fund, operation and maintenance charges, and that after ten or twelve years, when the toll rates will have been somewhat reduced from initial figures, amortization of construction cost may be commenced.

Monsarrat & Pratley of Montreal and J. B. Strauss of Chicago are the designing and supervising engineers. Quinlan, Robertson & Janin and the Dufresne Construction Co., both of Montreal, are the contractors for the south and north halves of the substructure work, and the Dominion Bridge Co. of Montreal is the contractor for the fabrication and erection of the steelwork.

Salt Content of Colorado River Water

New data on the dissolved solids of the Colorado River water have just been published by W. D. Collins and C. S. Howard as water supply paper 596 B of the U. S. Geological Survey. The principal sampling was done at Grand Canyon and Topock, Ariz. For an entire year the weighted average of results shows that the river transports per day 28,000 tons of dissolved solids, and has a mean discharge of about 20,000 sec.-ft. (40,000 acre-ft. per day), so that the water carries about two-thirds ton of salt per acre-foot.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Steam-Cleaning for Stone Work

FOR cleaning limestone fronts of large buildings effectively and economically, and without damage to the stone, a steam-jet process has been developed in a co-operative study by the Indiana Limestone Quarrymen's Association and the U. S. Bureau of Standards. One of the difficulties was the design of a nozzle by which the steam jet or spray would cover a sufficient area for rapid work and for the avoidance of a streaky appearance. The nozzle now used covers a strip about 4 in. wide and thus enables the workman to cover a surface uniformly and rapidly. In operation, the nozzle is held almost directly against the stone and is passed over the surface with a steady sweeping motion, as with a paint brush. It is always directed downward, so as not to spread the dirty liquid over the cleaned stone. Water is used to rinse the surface. The speed of the work depends upon the skill of the men, the kind of dirt, the steam pressure and the design of the building.

For new stone, a pressure of 100 to 125 lb. is considered sufficient, but on old stone it is necessary to use 150-lb. In a working day, a scaffold width of 22 ft. has been cleaned on twelve stories of new stone and eight stories of old stone. Several advantages are claimed for this process as compared with hand scrubbing, acid treatment or sand-blasting.

These nozzles are supplied by the Indiana Limestone Co., Bedford, Ind., to contractors who undertake cleaning, the contractors furnishing the necessary boilers and piping.

Designing Pavement Crown

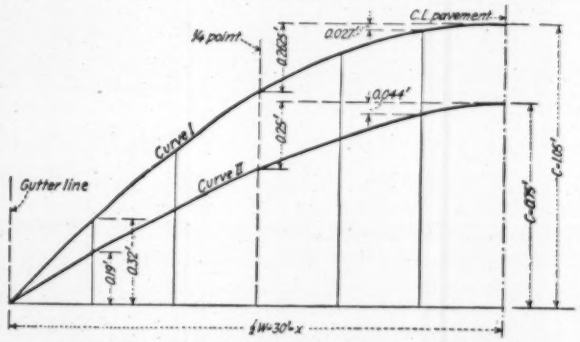
By Ernest S. Ross
Consulting Engineer, Tokio, Japan

ALMOST all paving engineers shape the cross-section of pavements on city streets according to the ordinary parabola, $y = x^2$, and calculate the crown by Rosewater's formula,

$$C = \frac{W(100 - 4f)}{5{,}000}$$

in which C is the crown height in feet; W the width of the pavement in feet; and f the longitudinal slope of the street in feet per 100.

For several years the writer has used a modified form of these two formulas with good results. Using the parabola equation, $y = x^2$, the quarter point is dropped one-fourth the crown height, while with the equation which the writer uses, the quarter point is dropped one-third the crown height. This equation is developed from the general parabolic equation, $y = Ax^n$, in which A becomes unity by placing the apex of the curve at the origin. Passing this curve through the point $\frac{1}{2}$, $\frac{1}{3}$, n equals 1.58497 and the equation then becomes $y = x^{1.58497}$. The difference in using this equation consists in dropping the quarter point one-third instead of one-fourth the crown height. When using this latter equation the figure 7,000 can be used as the denominator in Rosewater's formula and the result is better drainage at the crown of the street and less cross slope at the gutter. These two curves are illustrated in the accompanying sketch, showing one-half the width of a 60-ft. street, in which curve I is plotted from the equation $y = x^2$, and curve II from the equation $y = x^{1.58497}$.

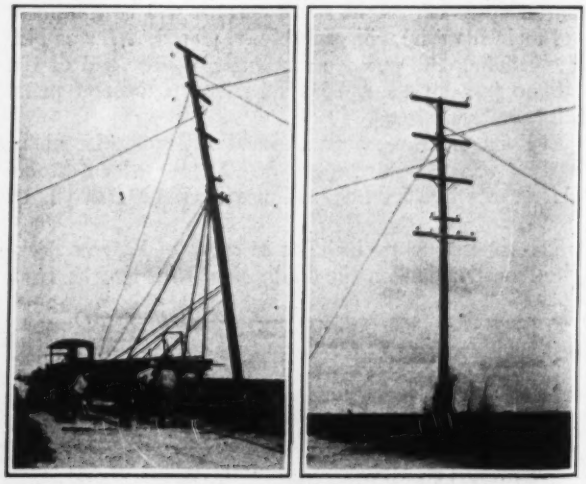


CURVES OBTAINED FROM TWO EQUATIONS

Setting Poles in Swamps by Blasting

A RAPID and inexpensive method for setting line poles in soft or plastic soils has been developed by the Phœnix Utility Co., Miami, Fla. This method consists of setting the pole vertically in its proper position and blasting a hole of the proper depth directly beneath it into which the pole settles.

The explosive is placed in the ground at the required location and depth by driving a length of 1½-in. pipe vertically into the ground, forcing the soil out of the bottom of the pipe with a ram, and dropping the explosive into the bottom of the pipe. The pipe is then withdrawn and the pole placed vertically, properly braced, directly over the explosive charge. Light poles may be



METHOD OF SETTING POLE
Left: Erecting pole over charge placed in ground. **Right:** charge exploding with rigging holding pole in place

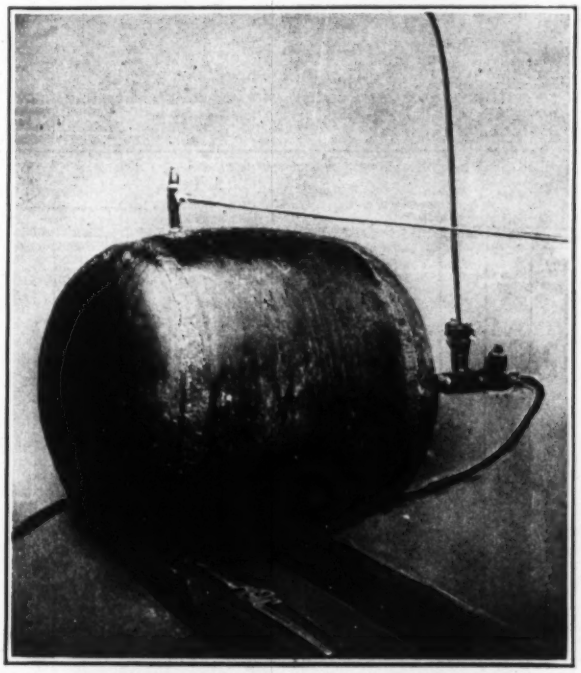
held in place with pike poles, while the heavier poles require four-way rigging for plumbing and holding. The charge is set off electrically and the pole drops into the pocket formed by the explosion. The ground recedes quickly and is forced solidly around the pole.

This method has been used to set poles having lengths up to 110 ft. and extending 14 to 16 ft. in the ground. The explosive charge is varied according to the nature of the soil and the depth of the hole desired. From 2½ to 5 sticks of 40 per cent dynamite is the usual charge.

In common soils where it is possible to dig holes without danger of caving before the poles are set this method is declared impracticable, as the explosion would scatter the soil, making backfilling necessary.

Steel Drum with Welded Seams Withstands Heavy Pressure

A STEEL DRUM having all seams arc-welded was subjected to a pressure of 3,000 lb. per sq.in. without failure at a recent demonstration at the Sharon, Pa.,



DRUM UNDER 2,500 LB. PER SQ.IN. PRESSURE
Note lengthening of drum by bulging of ends due to high pressure.

plant of the Petroleum Iron Works Co. and its associate, the Penstock Construction Co.

The test was one of several made in the presence of about 30 engineers representing various industries who were interested in the results of the research and progress made with electro-metallic arc welding.

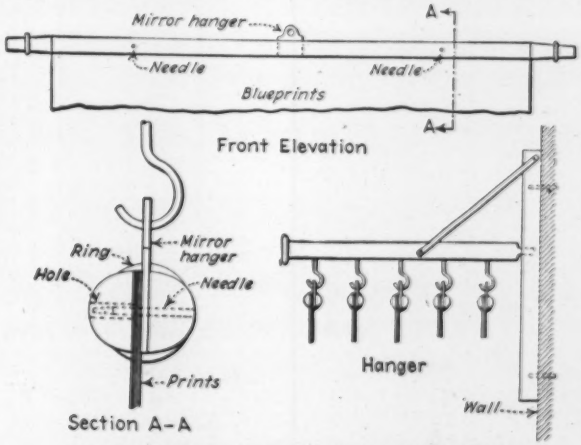
Several containers, completely welded by this method, were subjected to destructive pressures. In every case where a fracture occurred, it was in the plate at some distance away from the weld. One of the containers, 3 ft. in diameter and 2 ft. 6 in. in length, with dished heads and a one-piece shell, all of ¾-in. plate, was subjected to successive hydraulic pressures of 1,500, 2,500 and 3,000 lb. per sq.in. without showing a trace of moisture at any of the joints. At 3,090 lb. per sq.in. the hydraulic connection blew out and the test to destruction was not made. However, the container had lengthened 5¾ in. and increased almost 14 in. around the circumference midway between the heads. The computed bursting pressure was 2,100 lb. per sq.in. and the tensile strength for the steel was figured at 50,000 lb. per sq.in. The internal pressure of 3,090 lb. per sq.in. reached in the test corresponds to a tensile strength of 73,500 lb. per sq.in. in the shell.

Filing Blueprints to Make Them Readily Accessible

By Royden E. Reed
Assistant Engineer, L. H. Shattuck, Inc.,
Manchester, N. H.

TO FILE some 500 blueprints covering several construction operations so that each print is readily accessible presents somewhat of a problem. We have tried and discarded several means, but now we use the following method, a highly satisfactory one. It was necessary, to begin with, that certain sizes of binders be chosen as standard and it was found that if we made the binders 26, 33 and 36 in. long, overall, we would be able to bind nearly all prints we had on hand. This would not cover many of the full-sized details but these we filed, folded, in drawers.

The binding material was ⅝-in. half-round and was made in the following manner: The sticks were first cut to the chosen length and it was calculated that this length would allow the binder to protrude at least 2 in. on either side of the plans to be bound. In the center of the flat face of one piece was bolted a brass mirror hanger (bolts being used in preference to screws to stand rough usage) for the suspension of the plans after binding. In two places, equidistant from either end of the piece containing the hanger soft phonograph needles were driven through the binder from the



BINDER AND HANGER FOR BLUEPRINTS

curved face. These needles projected about ½ in. beyond the flat face. Then ⅛-in. holes, to receive the needles, were drilled in the other half of the binder at points opposite. Care should be taken to get the needles close enough together to take the smallest size of print to be bound.

The two halves of the binders were then placed together and 2 in. of either end tapered with a block plane so that a steel key ring 1⅛ in. inside diameter, would firmly seat about 1 in. from either end when

pushed on. This completes the binder. It will be found that twenty to thirty prints will be easily accommodated in each binder. The support for the prints is of a type sold commercially for clothes closets and is shown in the accompanying sketch. It folds up flat against the wall when not in use.

Indexing is largely a matter of personal taste but we handle ours in the following manner. Each print as it enters the office goes to the estimating department where it is indexed on a card, and the sheets are filed in the binders under the following headings:

1. General Plans
2. Architects Details
3. Engineers Details
4. Sub-Contracts
   - A. Steel
     - a. Structural
     - b. Miscellaneous Iron and Steel
     - c. Reinforcing
     - d. Etc.
   - B. Stone
     - a. Artificial Stone
     - b. Limestone
     - c. Marble
     - d. Granite
     - e. Etc.
   - C. Finish
     - a. Kalemein Doors
     - b. Metal Windows
     - c. Hollow Metal Jambs
     - d. Etc.
   - D. Miscellaneous
     - a. Elevators
     - b. Equipment
     - c. Etc.

Time Distribution Sheets Aid Assembly of Cost Data

RECOGNIZING that the permanence and advancement of a contracting business are dependent not only on construction technique, but upon accurate accounting and cost determination, L. E. Whitham of L. E. Whitham & Co., contractors, Wichita Falls, Texas, has devised an efficient system of time distribution. The company does extensive concrete paving work, operating a large central mixing plant, which explains the time report and distribution sheet for a street crew reproduced herewith. There are similar sheets for repair work, mixing plant crew, truck operation and car unloading. The company is also now engaged in constructing a new sewage plant for the city and distribution sheets on this job include those on the two-story settling tanks, sludge drying beds, dosing tanks, mixing filters, final settling tanks, etc.

L. E. WHITHAM & CO.

TIME REPORT STREET CREW

Job_____ _____ 192__

A Moving to job
B Forms
C Reinforcing
D Subgrade
E Placing concrete in pavement
F Finishing pavement
G Placing and finishing curb
H Curing
I Sealing joints
J Watching
K _____
L _____
M _____
N _____

L. E. WHITHAM & CO. JOB_____

DISTRIBUTION SHEET—STREET CREW _____ 192__

NO.	NAME	ON	OFF	TIME AND DISTRIBUTION	RATE	AMT.	A Moving to job	B Forms	C Reinforcing	D Subgrade	E Placing concrete in pavement	F Finishing pavement	G Placing and finishing curb	H Curing	I Sealing joints	J Watching	K	L	M	N

TYPICAL TIME REPORT-DISTRIBUTION SHEET FOR TRUCKING OPERATION

From Job and Office

Hints That Cut Cost and Time

As will be noted, each class of work is divided into a number of subdivisions which are given letters. These letters are used only for convenience on the distribution sheets and are not carried as ledger accounts.

The combination time report and distribution sheet is carried on the job by the timekeeper and each man's time noted together with the nature of the work he is doing as indicated by the proper letter. At the end of the day the distribution of each man's time is extended under the proper column. These columns are then totaled and cross-footed, the total of each column being posted to a sheet with columns headed with the same description and operation as appear on the daily sheet. This general sheet serves for the entire payroll. Its total at the end of the period serves as a summation of the figures from the daily reports.

These totals from the summation sheets go into the payroll voucher and balance with the amount of the payroll. The voucher is posted to the cost accounting ledger which is divided into as many segregations as are considered essential for obtaining the desired cost data although not necessarily as many segregations as are shown on the distribution sheet.

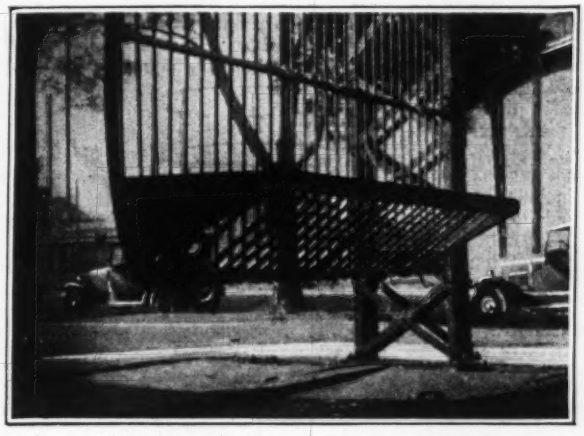
On the distribution sheet for the two-story settling tank, the following segregations of work appear and may be considered typical of the degree to which such work is divided: Excavation, hand trim excavation, backfill to original ground, embankment, sodding embankment, cutting, bending and placing reinforcing steel, concrete forms, erection and shifting concrete placing plant, placing concrete, deflectors, hauling pipe and fittings, placing pipe and fittings. There are also several blank lines left for such other segregation as the timekeeper believes desirable.

From Job and Office

For Contractor and Engineer

Galvanized Pipe Substituted for Rods in Sewage Screens

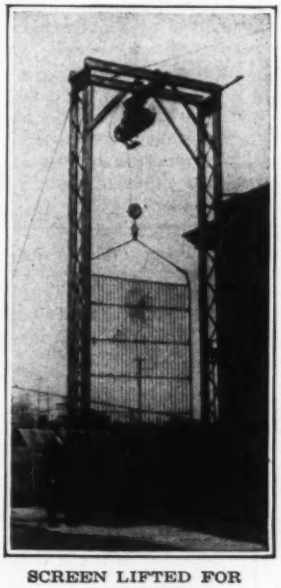
GALVANIZED pipe has been substituted for round iron rods in screens at the sewage pumping plants of Sacramento, Calif. The function of these screens,



SHELF ATTACHED TO BOTTOM OF SCREEN

which are several feet upstream from the ordinary inclined bar screens, is to catch any large objects that may come down the sewer. The screens are raised vertically for inspection and the removal of accumulated debris.

The screen consists of an 8x10-ft. frame made chiefly of strap iron, ⅜x2½ in. in section. Several such straps, placed horizontally, stiffen the frame and provide intermediate guides through which the pipes pass. The pipe sizes range from ⅜ to ¾ in. according to the surplus stock or used pipe from any source that city departments happen to have on hand when the screens are made up. The sizes are used indiscriminately except that only one size is used in any one frame. The lengths are made up with standard couplings and are fastened in the frame by making longitudinal hack-saw cuts in the pipe at the ends, spreading the strips between cuts by wedges, and bending them outward and downward over the top bar in the frame.



SCREEN LIFTED FOR CLEANING

At the bottom of the rack is a shelf or basket made of strap iron fastened rigidly to the frame and inclined slightly toward the rack. This shelf brings up anything that might otherwise fall from the rack as it is being raised for cleaning.

Concrete Railroad Viaduct in Service 8½ Days After Pouring

By L. A. Perry
Former Construction Engineer, The Longview Co., Longview, Wash.

MAIN-LINE railroad traffic proceeded over a reinforced-concrete subway constructed in Longview, Wash., 8½ days after the last portion of the roof slab was poured. Standard portland cement was used without the addition of any quick-setting or hardening mixtures.

This subway carries a main highway under 12 tracks of the Longview, Portland and Northern Ry. yard and is of flat-slab design and about 300 ft. long. Concrete was proportioned by the water-cement ratio, using 5½ gal. per sack of cement in the floor slabs and 4½ gal. per sack of cement in the roof slab. The latter slab, which was poured last, was designed to develop 3,200 lb. per sq.in. in 7 days.

Test cylinders of the mixtures used were made and

TRAIN PASSING OVER CONCRETE 8½ DAYS OLD

taken from batches at random. One-half of these were broken after 7 days and showed an average compressive strength of 3,600 lb. per sq.in. The remaining half developed an average strength of 6,200 lb. per sq.in. in 28 days. During the curing period the sandy backfilling material was placed and settled with water and the ballast and tracks were replaced. At exactly 8½ days after the roof slabs had been poured, the first train was allowed to proceed over the new structure without any signs of failure.

The work was done by the Olympic Construction Co., under supervision of the writer.

Job and Office Notes

Pavement on a High Sand Fill, using an inverted or concave section to prevent erosion of the fill by drainage, was laid on the new approach to the M St. bridge, Sacramento, according to a description in *California Highways,* the official publication of the California Highway Commission. The drainage is carried along the center of a 30-ft. pavement laid in three 10-ft. strips, by sloping the outer strip 1¼ in. and depressing the center of the middle section 1 in., making a total slope of 2¼ in. to the center. Drainage is collected in two catchbasins covered with cast-iron gratings flush with the pavement, one located halfway down the steepest grade and the other at the foot of the grade where transition is made to the standard crown section.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Canada Not Ready to Make Report on St. Lawrence

The Canadian Government, in reply to Secretary Kellogg's letter of April 13, 1927, asking Canada's views as to further negotiation on the St. Lawrence waterway, states:

"The national advisory committee appointed by the Government of Canada to report on the economic and general aspects of the St. Lawrence waterway question will not be in a position to make a final report until all the findings of the joint engineering board including the appendices are available. Upon receipt of the report of the national advisory committee and upon consideration of the other factors involved, the Government of Canada will be able to determine its policy on the question, and will then have pleasure in discussing further with the Government of the United States at as early a date as possible the whole situation." The appendices referred to contain the details of the projects and the estimates of the cost. It is expected that they will be available soon.

International Bridge Project at Port Huron, Mich.

A movement is on foot to construct a bridge across the Detroit River between Port Huron, Mich., and Sarnia, Ont. Maynard D. Smith, of Detroit, and associates are promoting the movement. Financing arrangements are said to have been completed, and work on engineering preliminaries, survey and traffic studies is to begin at once. The promoters have arranged with Joseph B. Strauss, consulting engineer, Chicago, to prepare plans and specifications for the bridge.

Water and Sewage Operators Meet at State College

Both the Water Filter Plant Operators of Pennsylvania and the Sewage Works Operators of Pennsylvania held annual meetings at State College, Pa., the first on July 12 and 13, and the second on the two following days. There were about 70 present at each meeting. The Sewage Plant Operators effected a permanent organization, as follows: President, Prof. Elton D. Walker, State College, Pa.; first vice-president, H. E. Moses, assistant chief engineer, Pennsylvania Department of Health, Harrisburg, Pa.; second vice-president, Major L. E. Burnside, city engineer, Sharon, Pa.; secretary-treasurer, Prof. R. O'Donnell, State College, Pa. The Water Filter Plant Operators appointed a committee of five to report plans for a permanent organization at the next annual meeting.

Hoover Outlines Needed Flood Relief

Federal Government Should Assist the Local Levee Boards—Wider Control Work Needed

In a report made to the President on the flood situation in the Mississippi River Valley, Secretary Hoover has stated that sufficient funds are available to care for the people in the flooded regions until Congress meets and to repair the levee system. He believes that the Federal Government control work should be extended to include the tributary rivers and that additional funds estimated at from 50 to 20 million dollars a year over a period of ten years should be made available for river regulation and flood control.

Secretary Hoover looks to the levee system as the major line of defense and suggests that it be strengthened and that added protection for the New Orleans region should be provided for by spillways.

An abstract of Secretary Hoover's report as given to the press is as follows:

It seems clear that the flood control must embrace the following principles:

Higher and consequently wider levees and the extension of federal responsibility for levees on some of the tributaries.

A safety valve upon the levee system by the provision of a spillway or more properly called a "by-pass" to the Gulf to protect New Orleans and Southern Louisiana, most probably using the Atchafalaya River for this purpose.

For further safety measures the engineers are examining the possible extension of the by-pass in the northward from the Atchafalaya toward the Arkansas, the possible erection of emergency flood basins and the possibilities of storage in the tributaries.

There is no question that the Mississippi River can be controlled if a bold and proper engineering plan is developed.

The cost of such work if spread over ten years would be an inconsiderable burden upon the country. It is not incompatible with national economy to prevent $10 of economic loss by the expenditure of $1 of federal outlay. In the face of their great losses and their present destitution I do not see how the people along the river can contribute much more than the maintenance of the central works after they have been once constructed.

Relief Measures

Flood relief embraces four stages with four organizations required, i.e., rescue, care of exiles, rehabilitation and flood control. The situation at this date is:

The rescue organization has been demobilized. Several hundred thousand people were brought out of the water and since President Coolidge directed the consolidating of all effort on April 21, there has been a known loss of only three lives. The refugee organization has also been largely demobilized.

Of a total of 700,000 people flooded, 608,000 were dependent upon public relief for food and shelter for six to eight weeks. All but 20,000 of the people in camps have now been returned to their homes, although 150,000 are still being fed in their homes.

Such health conditions have been maintained in camps that the total deaths were actually less than the births. The people generally were sent home better clothed and in better health than when they were brought to the camps.

The county reconstruction committees are making substantial progress with rehabilitation. In 101 counties, considerably flooded, 2,000,000 acres of crops that were lost have been replanted with staple crops mostly from seed furnished by the relief. We hope the majority of this acreage was planted early enough to secure a full crop. This area should, with the help being given, recover to self-support by the fall.

On the other hand, about 1,500,000 acres of original crops, mostly in twenty counties, have remained under water so long as to prevent planting of staple products, and so recovery will be delayed for another year.

The inability to pay interest, state and

Recent Blasts Do Small Damage To Los Angeles Aqueduct

Two explosions of dynamite in open canal portions of the Los Angeles Aqueduct occurred late on July 15 and early on the following morning within about fifteen miles of one another. This marks a new attack in the warfare that has been active along the aqueduct for several months. For reports of previous dynamiting see *Engineering News-Record* June 9, 1927, p. 960.

"These two blasts did little damage," says a statement to *Engineering News-Record* from the Los Angeles Bureau of Water Works and Supply under date of July 22, "but appear to be demonstrations in line with the apparent effort of the dynamiters to terrorize Los Angeles into paying reparation demands. The first of the two recent blasts destroyed a wooden gate in the upper unlined portion of the aqueduct, the damage being so slight that it was repaired within one day. The second blast damaged side walls in the open concrete line section of the aqueduct near Lone Pine and caused damage that took about two days to repair. The aqueduct is now running clear."

"The situation generally is that reparations claimants have refused to accept the plan of Governor Young that they file their reparation claims in the courts and follow regular methods provided by law for collecting any damages proved to be suffered and which can legally be paid by Los Angeles. Under the reparation law adopted by the State Legislature two years ago at the instance of Owens Valley, reparations claims must be filed in court by July 22. No such action has yet been taken by the reparationists."

levee taxes, and for some individuals among them to find food for winter, may create a continuing problem.

In all counties the destitute flood sufferers were furnished with a supply of food and fed upon leaving the camps, and, if their homes were destroyed, were given their tents. Repairing damaged homes and building new for those who cannot provide themselves are now in progress. It cannot all be done in a day, but these services should all be completed by October. Sanitary measures are being set up in every county to put down malaria and other communicable diseases.

FINANCIAL SITUATION

The financial situation is that with economy we can complete all these programs—seed, fuel, food, furniture, animals, house construction and sanitation. By the first of November we estimate that we shall have spent on the whole relief operations $13,400,000 from the Red Cross fund, $7,000,000 equipment and supplies from the federal government, $3,000,000 free railway transportation and provided $1,100,000 for county health clean-up units from other sources. With economy we should have left $3,000,000 from the $16,500,000 subscribed to the Red Cross with which to face continued necessities after Nov. 1.

It is impossible at this date to determine what the necessities will be after that date. That can only be told when we have a chance to examine the actual situation as to the crops, amount of employment and the volume of need in other directions.

We will make an exhaustive investigation into the question during the fall and will establish further co-operative measures. Whatever else may be provided by the state legislatures in relief from taxation certainly they should have immediate relief from the federal government from repairs to the levees. The greatest of all measures needed is prompt and effective flood control and quick legislation, for that will restore confidence and there will follow a recovery in values and in business.

San Gabriel Dam Contract Award Delayed by Injunction

The award of the contract for the San Gabriel dam for the Los Angeles County Flood Control District has been delayed by a temporary injunction issued July 21 directing the county supervisors to appear in court July 28 and show cause why they should not be permanently enjoined from building the proposed dam to form a 180,000-acre-ft. reservoir recommended in the report made in March, 1927, by a board of consulting engineers—F. H. Fowler, C. D. Marx and Charles H. Paul—instead of the dam to store 240,000 acre-ft. provided for in Reagan's original plan. The suit was brought by several cities, organizations and individuals who contend that the unexpectedly low bids opened July 11 shows that a dam of the size originally contemplated could be built within the $25,000,000 bond issue and that to adopt plans for a dam of smaller size would invalidate the bonds. The opposition to the lower dam is reported to be supported by F. J. Safley, Louis C. Hill and Harry Hawgood, three engineers who have been previously identified with the San Gabriel controversy (see *Engineering News-Record*, April 7, 1927, p. 570).

C. & O. Ry. Plans to Spend $12,000,000 At Cincinnati

Plans Double-Track Ohio River Bridge, Grade Crossing Bridges and Terminal Improvements

Announcement is made by the Chesapeake & Ohio Ry. of extensive improvements to be made at Cincinnati and Covington, on opposite sides of the Ohio River, with an aggregate cost of about $12,000,000. Parts of this program are in connection with the general improvement of railway passenger and freight terminals at Cincinnati. The largest item is the new double-track Ohio River bridge, on the downstream side of the present bridge, which will consist of two 450-ft. shore spans and a 675-ft. channel span. The present structure will be converted into a highway bridge, the tracks being removed and a concrete slab deck laid to provide a three-lane driveway between the trusses. The railway viaduct approaches will also be removed and replaced with highway approaches, using the present highway entrances.

On the Ohio side, the railway viaduct approach from Mill St. will be replaced with a modern structure; from Mill St. to the Big Four R.R. the present single-track viaduct will be replaced with a double-track steel viaduct. The Inter-Terminal R.R., from 2nd and Smith Sts. to 5th and Baymiller Sts., with its steel viaduct, will be double-tracked.

FIVE NEW OVER CROSSINGS

On the Kentucky side, the approaches to the Licking River bridge, about 1,000 ft., will be rebuilt and provided with modern structures. Between this bridge and the Covington yard, five bridges over streets will be renewed with modern structures, having concrete-slab and ballasted floors carrying the track. Two viaducts, about 400 ft. in length, will be filled. At Madison Ave. the present grade crossing will be eliminated and underpass provided. At the passenger station in Covington, the tracks will be elevated about 16 ft. and three 900-ft. covered platforms provided, one on each side of the four tracks and one in the center, so that all tracks will be served by platforms. The platforms will be reached by a subway, with stairs and baggage elevators to serve each platform.

The tracks between 15th St. and the south bank of the Ohio River will be raised on fill, so that the grade will be 0.3 per cent as compared with 1 per cent at present. Four tracks will be added between 12th St. and 8th St., making six tracks; and two tracks will be added from 8th to 6th St., making four tracks between these points. From 12th St. to 6th St. inclusive, the present grade crossings will be eliminated and overhead bridges or subways provided, except that 9th St. will be closed. From 5th St. to the new Ohio River bridge a modern double-track viaduct with concrete-slab ballasted floor will be built.

Commission Orders Union Depot for Los Angeles

Three steam railroads entering Los Angeles are ordered to unite in the construction of a union passenger terminal in the Plaza area of that city by an order issued by the California Railroad Commission on July 8 after 16 years of investigation and controversy. The railroads affected are the Santa Fe, Southern Pacific and Union Pacific. The order requires that work be begun within 90 days and completed within three years after the verification of the order by the Interstate Commerce Commission. This verification is expected without delay because the Interstate Commerce Commission in 1925 found that "public convenience and necessity" required a union depot at the Plaza site and indicated it would approve a state railroad commission order to this effect (see *Engineering News-Record*, Dec. 22, 1921, p. 1039).

Chicago's Latest Dodge in Metering

A proposal to reduce Chicago's excessive water consumption by waste prevention, instead of by the metering program now required under the agreement with the War Department, is proposed by representatives of the mayor, who opposes the metering program. The present agreement provides for complete metering in ten years as a condition for the temporary permit for a flow of 8,500 sec.-ft. to the drainage canal, but under the proposed plan meters would be required only for industries and large consumers and not for residences. It is claimed that about $6,000,000 would be sufficient for a water waste survey and the stoppage of leaks and waste. This plan is to be submitted to the city council's finance committee, which already has before it an ordinance repealing the existing metering ordinance.

River and Harbor Funds Not for Mississippi Repairs

Comptroller General McCarl has ruled against the use of river and harbor funds in the rebuilding of levees on the Mississippi River. In his opinion he says in part:

"There is no general or special provision of law that would authorize the approvel of an expenditure for repairs or restoration of damaged or destroyed levees in excess of the amount appropriated for the fiscal year 1928, which is $10,000,000. The situation presented would appear to be for the consideration of Congress."

The decision also reveals that the President had specifically approved the proposal to use $2,000,000 of river and harbor money for emergency work on the levees. General Jadwin had requested that this $2,000,000 be transferred from the river and harbor appropriation of $50,000,000, in order that the breaks in the levees should be closed before next year's high water. Of the

$10,000,000 under the War Department Appropriation Act of February, 1927, approximately $4,000,000 has been expended in flood fight and rescue work. Of this amount the Mississippi River Commission estimates that $605,000 must be expended for dredging before December 1, and about $2,530,000 for essential revetment work, leaving available for levee work only about $3,135,000. Ordinarily the levee districts are required to contribute one dollar to each two dollars of Government allotment. Many of the districts now are unable to make their contribution and a shortage of funds from this source is practically certain.

Cambridge Zoning Ordinance Upheld in Massachusetts

The zoning ordinance of Cambridge, Mass., was upheld by the full bench of the Supreme Court of Massachusetts in a decision rendered July 8. Saul M. Newtow, owner of 140,000 sq. ft. of land in a section zoned as residential, claimed that the ordinance was unreasonable, deprived him of the equal protection of the law and took his property without due process of law. Shortly before the passage of the ordinance he had contracted with a business company to sell 51,000 sq.ft. of his land at $1.24 a foot. After the ordinance was passed the company refused to accept a deed for the land because of the zoning restrictions. A master who took evidence in the suit reported the conclusion "that no practical use of the land" can be made for "residential purposes."

The opinion says in part: "Courts cannot set aside the decision of public officers in such a manner unless compelled to the conclusion that it has no foundation in reason and is a mere arbitrary or irrational exercise of power having no substantial relation to the public health, the public morals, the public safety or the public welfare in its proper sense.

"The case at bar is close to the line, but we do not feel justified in holding that the zoning line established is whimsical, without foundation in reason. In our opinion it is not violative of the rights secured by the plaintiff by the constitution, either of the Commonwealth or by the Fourteenth Amendment to the Constitution of the United States."

Kansas City Free Bridge Opened

By agreement between the municipal authorities of Kansas City, Mo., and the North Kansas City Development Co., the highway over the company's Missouri River bridge was made free to the public on July 15. The negotiations for this purpose were reviewed in *Engineering News-Record* of March 10, p. 424. The main part of the bridge and the approaches has a double-track railroad on the lower deck and a highway with double-track electric line on the upper deck. A through-truss span over the channel has the highway carried by the bottom chords, while the railway deck is suspended from the span by cables so that it can be raised for the passage of vessels. The company has received $1,350,000 from the city and $150,000 from Clay County (on the north side of the river). The city and the bridge company will pay $16,786 and $150,000, respectively, for the repaving and improvement of the highway, which work will be done by the State Highway Commission as the crossing will form a link in a main highway route.

Engineering Fifty Years Ago

From *Engineering News*, July 28, 1877

GEN. Beauregard, in a published letter of considerable length, under date of July 13, gives quite an exhaustive account of the progress thus far made upon the jetties at the South Pass of the Mississippi River, and predicts that they will be entirely successful.

Baltimore and Ohio Railroad Planning Exposition

For a two-week period, September 24-October 8, the centenary of the Baltimore and Ohio Railroad will be celebrated in Baltimore, Maryland. The Hall of Transportation is under construction and is now practically ready for the installation of exhibits which are designed to show the progress of railroad transportation in general as well as that of the Baltimore and Ohio during the last one hundred years.

Detroit-Windsor, Canada, Toll Bridge Bonds Issued

Financing of the Detroit-Windsor suspension bridge project (see July 7, issue, p. 30) was made definite last week when a syndicate of bankers headed by Hemphill, Noyes & Co., and Peabody, Houghteling & Co., of New York, placed on the market $20,000,000 of securities of the proposed bridge. The issue comprises $12,000,000 first mortgage 6½ per cent bonds with term of 25 years, and $8,000,000 participating 7 per cent, de-

GERMAN FLOODS CAUSE DISASTROUS TRAIN WRECK

AN UNDERMINED road bed at a stream crossing in the Harz Mountains near the German town of Wernigerode is said to have been the cause of a train wreck in which 8 persons were killed and 22 injured.

bentures also with 25-year term. According to a statement which accompanied the public offer, the Detroit International Bridge Co., "has entered into a contract with McClintic-Marshall Co., engineers and contractors, for the construction of the bridge under the terms of which certain bonuses accrue to or liquidated damages are payable by McClintic-Marshall Co. in the event of expedition or their delay."

Coverdale & Colpitts, engineers, are quoted as reporting that the first year's net income before depreciation and income taxes may be expected to exceed $2,000,000, and that the annual income during the next ten years should average more than $3,500,000.

Plans and specifications have been approved by Monsarrat & Pratley, consulting engineers of Montreal, and by Ralph Modjeski and C. E. Chase of New York. The latter have been retained to act as consulting engineers during construction.

The capitalization of the bridge company includes 100,000 shares of no-par-value common stock, and an authorized amount of $5,000,000 of 6 per cent cumulative preferred stock, of which latter $1,400,000 has been issued.

As previously reported the bridge will extend from near 21st St., a short distance west of the Michigan Central Terminal, Detroit, to Huron Line Road, Sandwich, Ontario. It will be a suspension structure with main span of 1,850 ft. and total length of about 7,542 ft., carrying a 47 ft. roadway.

Brief News

THE INDIANAPOLIS BOARD OF PUBLIC WORKS has recommended a 6-cent track elevation levy, a 5-cent street resurfacing levy and a 3-cent thoroughfare plan levy, all made irrespective of the board's regular budget. The track elevation levy for 1926 was 2 cents. The proposed resurfacing levy is $574,500, which would be set against the estimate of the city engineer's office, which amounts to $766,000 for streets that are subject to resurfacing.

SURVEYORS OF THE COLORADO STATE HIGHWAY DEPARTMENT are making a survey for a new road—Mosca Pass Highway—which it is said will mean a shortening of the distance between the San Luis Valley of Colorado and the cities of Pueblo, Colorado Springs and Denver by fifty miles.

CONTRACT FOR DREDGING THE CHANNEL in Olympia, Washington Harbor, involving the removal of 250,000 cu.yds. of material has recently been let to the Puget Sound Bridge & Dredging Co., Seattle, on a bid of 10½ cents. The second low bid was that of the Tacoma Dredging Co., at 11.8 cents. The contract is part of the plan to dredge the channel to a 150 foot width. The work is being done for the United States Government.

Washington Notes

MAJOR Glen E. Edgerton, chief engineer, Federal Power Commission, is enroute to the west coast where he will visit all of the projects on which the Commission will be required to take action in the near future. He will visit the projects of the Southern California Edison Co. at the head waters of the San Joaquin River; the project of the San Joaquin Light & Power Co. on Kings River; several sites on the Tuolumne River; the projects of the Southwest Power Co. on the Feather River; and those of the Pacific Gas & Electric Co. on the Pitt River as well as those of the city of Seattle.

APPLICATION has been made by B. T. Davis, Tampa, Fla., for approval of plans for a bridge to be constructed over Old Tampa Bay from Spruce Street, Tampa, to the Gulf at Bay Boulevard, near Clearwater, Fla., under authority of the state law.

THE Federal Power Commission's technical staff is now analyzing the designs for the City of Seattle's Diablo Canyon arch dam. It is to be 385 ft. high and four designs have been submitted. The studies have progressed far enough to leave little doubt that the site is well adapted to a dam of that type. A protest against the impounding of such a large amount of water has been filed on behalf of the people below the dam who would be endangered in case of its failure.

OVER the protest of the Tennessee Eastern Electric Co., the Federal Power Commission on July 8 held that power projects on the Holston River and its tributaries would affect nevigation on the Tennessee River, and as a consequence took jurisdiction over the projects covered by the applications of the Tennessee company and the Holston River Power Co. The Chief of Engineers in his report states that the proposed construction would have an adverse effect on interstate commerce, while the representatives of the Tennessee company contend that the development is too distant from the head of navigation at Chattanooga to have any effect on the river at that point. For this reason they held that state rights alone were necessary.

Personal Notes

C. G. EMIL LARSSON has been appointed chief consulting engineer in charge of technical engineering and bridges of the American Bridge Co., succeeding the late Charles W. Bryan.

JAMES H. EDWARDS has been appointed chief engineer in charge of engineering forces and buildings of the American Bridge Co.

GEORGE H. KOHL, for several years past hydraulic engineer for the Spanish River Pulp & Paper Co. of Sault Ste. Marie, Ontario, has resigned and will practice as a consulting engineer at Sault Ste. Marie.

DR. H. L. BALDWIN, associate professor of civil engineering at the University of Utah for the past nine years, has accepted a position with the board of state harbor commissioners at San Francisco, Calif., having been granted a year's leave of absence from the university.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Boston, Mass., Sept. 13-16, 1927.

AMERICAN WELDING SOCIETY, New York City; Fall Meeting, Detroit, Mich., Sept. 19-23, 1927.

ASPHALT PAVING CONFERENCE: Under the auspices of the Asphalt Association and Association of Asphalt Paving Technologists; annual conference Atlanta, Ga., Nov. 28-Dec. 2, 1927.

Obituary

DR. ARTHUR A. HAMERSCHLAG, who was president of the Carnegie Institute of Technology for 19 years, 1903 to 1922, died July 20 in a hospital in New York City, following an operation; he was 54 years of age. At the time of his death he was president of the Research Corporation, New York City. Dr. Hamerschlag was born in Nebraska in 1873, was educated in the public schools in Omaha and later in New York; then establishing himself in engineering in Pennsylvania he received the degree of doctor of science from Lehigh University in 1907. Andrew Carnegie made him president of Carnegie Institute in 1907. During the war he was director of research in the office of Major Gen. George W. Goethals.

JAMES A. THOMPSON, of Poughkeepsie, N. Y., who in recent years built roads in southeastern New York State for the state highway department and who had long been connected with engineering work, bridge construction and road work, died July 11, aged 77 years.

WALLACE L. MARSHALL, 40 years old, head of a firm of bridge builders and consulting engineers of Lafayette, Ind., recently was burned fatally when his automobile caught fire, and died the next day. He had gone to Veedersburg, Ind., where he was erecting some bridges and was returning home when the machine broke into flames. He graduated from Purdue University in 1908.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Bucyrus-Erie Merger Completed

The directors of the Bucyrus Co. meeting in South Milwaukee, Wisconsin, and those of the Erie Steam Shovel Co. at a meeting in Erie, Pa., approved a plan on July 20 for the merger of the two companies. Inasmuch as the stockholders have three months in which to deposit their certificates and approval of the plan, no information is available relative to future manufacturing and marketing plans.

The plan of consolidation contemplates the formation of a new company, under the name of Bucyrus-Erie Co., to acquire a majority of the stock of both companies in exchange for which it plans to issue its own stock on the following basis:

(1) For each share of preferred stock of the Bucyrus Co. or of Erie Steam Shovel Co., one share of preferred stock of the new company.

(2) For each share of common stock of Erie Steam Shovel Co., one share of convertible preference stock of the new company.

(3) For each share of common stock of the Bucyrus Co., three shares of common stock of the new company.

Under the proposed plan the exchange of securities will not constitute a taxable profit under the present Federal Income Tax laws so long as the securities received in exchange remain unsold.

In the statement concerning the consolidation it is said that "Bucyrus Co. was originally organized at Bucyrus, Ohio, about forty-seven years ago and was reorganized at South Milwaukee in 1911. Its specialty has been heavy machinery, of which it has been a leading manufacturer in this country with increasingly large sales abroad. Erie Steam Shovel Co. was formerly the Ball Engine Works, Erie, Pa. In 1914 it turned to the steam shovel business. Its specialty has been in smaller shovels. The new company will have a complete line of machinery and very large assets, with average earnings over the past five years of approximately $3,300,000 a year."

Hotel Reservations for 1928 Convention and Road Show

The hotel committee of the American Road Builders' Association has exclusive control of all rooms in the best hotels in Cleveland, to which it has arranged to add a number of lake steamers upon which hotel accommodations can be secured for the convention, January 9-13, 1928. Because the exhibit area available is some 45 per cent larger than heretofore, it is expected that the attendance will be the largest on record. The hotel bureau will open Sept. 20, and all applications will be considered as bearing that date, although they may be filed at any time from now on. Requests for rooms should be addressed to A. J. Kennedy, vice-chairman Hotel Committee, American Road Builders' Association, 304 Chamber of Commerce Building, Cleveland, Ohio.

Bureau for End-Matched Pine Lumber Formed

The Southern Pine End-Matched Bureau became a permanent organization on July 12 by the adoption of bylaws and the election of officers. Assessments were set for member mills, and the proceeds will be devoted to merchandising activities in the interest of end-matched products. The purposes for which the End-Matched Bureau was organized are as follows:

(a) To standardize end-matched manufacturing practices.

(b) To improve methods and widen avenues of distribution.

(c) To develop and carry out plans for group advertising.

(d) To gather statistics relating to the end-matched part of the lumber business.

The offices of the Bureau are in New Orleans, La., with the Southern Pine Association.

Equipment for New England Water Works Meeting

Manufacturers who are planning to exhibit their equipment at the convention of the New England Water Works Association at the Hotel Statler, Boston, Sept. 13-16, should immediately send in their applications to the office of the Water Works Manufacturers' Association, Room 1200, 420 Lexington Ave., New York City.

Business Notes

HENRY H. MEYER CO., Baltimore distributor for a number of manufacturers of construction equipment, has just opened a new branch in Washington, D. C., at 1114 Ninth Street, N.W.

CYCLONE FENCE CO., Waukegan, Ill., announces the appointment of J. H. Kinney as general manager succeeding J. W. Meaker who resigned recently to become president of the Bates Valve Bag Co., Chicago. Mr. Kinney was formerly sales manager. H. G. Chapman, has been appointed general sales manager, A. W. Kirkham, treasurer, W. M. Jensen, assistant treasurer, R. E. Pinniger, eastern sales manager, with offices at Newark, N. J., and S. W. Burr, sales manager at Cleveland, Ohio.

GENERAL FIREPROOFING BUILDING PRODUCTS, Youngstown, Ohio, has changed its name effective July 1 to the Genfire Steel Co. The change is said to affect the name only and is made to avoid possible confusion with the General Fireproofing Co., also of Youngstown, makers of steel office furniture and equipment. Genfire Steel Co. will continue to manufacture a complete line of metal lathes, casement windows, steel joists, concrete reinforcement, waterproofings and similar materials.

AMERICAN HUME CONCRETE PIPE CO., Detroit, announces that J. A. Dunn has taken the position of chief engineer of the company. Mr. Dunn was formerly assistant secretary of the American Concrete Pipe Association and later chief engineer for the Independent Concrete Pipe Co., Indianapolis. Mr. Dunn succeeds W. D. Kimmel who has resigned to take over the management of the Detroit Hume Pipe Co., the Michigan licensee for the Hume process.

AMERICAN ROLLING MILLS CO., Middletown, Ohio has announced the acquisition of the Columbia Steel Co., Butler, Pa., and the Forged Steel Wheel Co., Elyria, Ohio. The new acquisition will give the American Rolling Mill another complete manufacturing unit for steel sheets and the control of about 1,000,000 tons of finished products annually.

INDUSTRIAL WORKS, Bay City, Mich., announces the closing of its district office at Tampa, Fla. The office at Atlanta, Ga., will handle the business in Florida, Alabama, Georgia, North Carolina, South Carolina and the eastern portion of Tennessee.

INDEPENDENT PNEUMATIC TOOL CO., Chicago, Ill., announces that M. J. Harkless has been appointed sales engineer of the contractors' department. Mr. Harkless was previously an engineer of the railway and marine supply department of the Buda Co., Harvey, Ill.

HARNISCHFEGER CORP., Milwaukee, Wis., announce the opening of a new branch office at 330 Gateway Bank Building, Minneapolis, Minnesota. P. H. Sackett, is district manager, and J. C. Yetter is sales engineer.

GALION IRON WORKS & MFG. CO., Galion, Ohio, announces that the Willamette Equipment Co., Portland, Ore., is now its authorized representative for the state of Oregon.

BUHL CO., Chicago, announces that W. J. Henry has joined the organization as assistant sales manager in charge of all Buhl Agencies. Mr.

Henry has been for the past five years with the Harnischfeger Corp. in the eastern territory. Mr. Henry is a graduate of Rensselaer Polytechnic Institute. He has also been connected as an engineer with the New York State highway department.

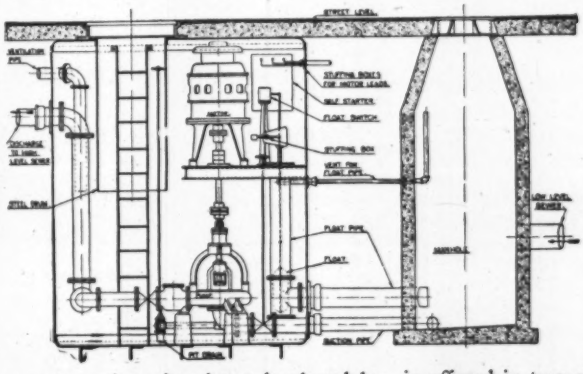
ROBERT C. STUBBS, the originator of Vibrolithic concrete and Interlocking Bituminous pavements, died in a hospital at Dallas, Texas, July 9, following an attack of pneumonia. Mr. Stubbs was 57 years old. He had been a resident of Dallas for the last 40 years. Mr. Stubbs was a charter member of the American Concrete Institute.

WILLIAM CHARLES KIDD, sales representative of the Ramapo Ajax Corp., Hillburn, N. Y., and secretary treasurer of the Track Supply Association, died at his home in Suffern, N. Y., on July 5. Mr. Kidd has been particularly active in the Track Supply Association, which is the organization of supply concerns which exhibits at the roadmasters annual convention.

New Developments

Watertight Pumping Station Protects Electrical Equipment

Where the installation of motors and controllers for sewage pumping stations must be located underground and subjected not only to condensation and lack of ventilation but also to complete submergence, there has been developed by Yeomans Brothers Co., Chicago, a flood-proof underground pumping station.

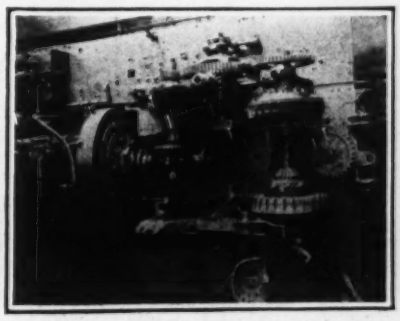


As shown in the accompanying diagram, the unique feature of this station is that owing to the steel drum which forms the entrance to the chamber and extends down to a point considerably below the level of the electrical equipment, the motors and controllers are located in an air-locked space in the upper part of the chamber. It is claimed that even with a considerable head of water over the top of the chamber and with the cover removed from the entrance manhole, the water in the chamber cannot rise far enough above the bottom of the entrance drum to reach the motor windings or electrical devices. Power wires are brought into the steel wall of the chamber with stuffing boxes and the ventilating pipes, if any, are carried down to the same level as the entrance drum so that air cannot escape at any point above this level. The pit drain valve, which is connected to the suction of the sewage pump, is provided with an extension stem running up into the entrance drum, so that after flood conditions have subsided the water remaining in the chamber can be pumped out. This flood proof chamber is said to be applicable for use with sewage ejectors and emergency pumps, both in municipal and city building installation.

New 1¼ Yard Shovel Powered by Diesel Engine

A new 1¼ yard shovel, dragline, clamshell and crane designated as model E-2, has recently been announced by the Bucyrus Co., South Milwaukee, Wis., to supplement its 1-yd. convertible Diesel shovel announced a few months ago.

Dependable power results from the Bucyrus two-part hoist, coupled with the Atlas-Bucyrus four-cycle 9 in. bore x 12 in. stroke Diesel engine. A safety clutch protects the engine against overload and guards against breakage. A box-girder type boom, patent rope crowd and outside dipper handles are other features of the machine. The shovel is offered in two sizes with boom 26 or 29½ ft. and dipper handles 15 and 17 ft. respectively. The dumping height ranges from 13 ft. 2 in. at 49 degrees with the standard shovel to 22 ft. 11 in. at 60 degrees with the high lift.



The dragline of the E-2 is offered with one yard bucket on a 45 ft. boom and a ¾ bucket on a 50 ft. boom. As a crane, the different boom combinations give the E-2 a lifting capacity as great as 22,750 pounds and a working radius as large as 53 ft. One of the accompanying illustrations shows a plan view of the machinery of a shovel with part of the Diesel engine showing at the left.

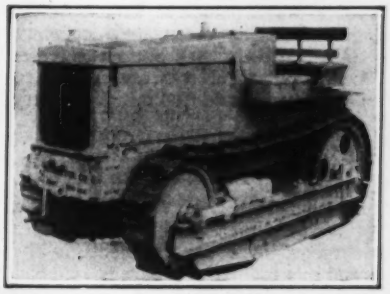
Huge Electric Generator Ordered by New York Edison Co.

An electric generator rated at 160,000 kw. is to be installed by the New York Edison Co. in its new station at 14th Street, East River, New York City. This generator is said to be nearly three times as large as any in service, and more than half again as large as any under construction in the world.

The generator will be driven by a tandem-compound steam turbine which means that all of the equipment will be mounted on a continuous shaft. The rating of 160,000 kw. is at 1.00 power factor, 1500 r.p.m., on a 3 phase, 25 cycle and 11,400 volt circuit. The entire set will be 82 ft. 7 in. long and will weigh 2,228,000 lb. The equipment which is being manufactured in the Schenectady plant of the General Electric Co., will be installed completely October 1, 1928.

New Tractor Model Simplified and Made Stronger

The plan of the JT Tractor Co., Cleveland, Ohio, in designing its new Model 45 crawler tractor, was to increase the size of all the parts and to decrease the number. The result has been that the Model 45 is claimed to have less parts than any other tractor built. It is a five-ton model powered by a 45 hp. Climax engine.



In the first place the yoke operating the front wheels has been simplified and is now carried by the top flange of the side channels. All possible gears have been placed in oil tight housings. The tension spring behind the front yoke is entirely encased in a steel casting and a better mud guard is provided over the adjusting nuts. The rear end of the side truck has been improved by new rear axle boxes. The rear axle mounted on Guerney ball bearings is entirely protected from dirt and dust and runs in oil.

The rear drive gear is an external gear and has been entirely encased in a dirt proof housing allowing it to run in oil. The same is true of the bull pinion shaft.

The main frame is made of two Bethlehem 10 in. beams with flanges 3½ in. wide. The front engine support is one steel casting supported on top of the beams and the engine has a three point support on the frame so that any distortion of the frame will not wrack the engine casting.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL HARDWOOD LUMBER ASSOCIATION, Chicago; Annual Convention, Chicago, Sept. 15-16.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; Semi-annual meeting, Aviation Country Club, Detroit, Sept. 19-21.

AMERICAN PAINT & VARNISH MANUFACTURERS ASSOCIATION, Philadelphia; Annual Convention, Atlantic City, Oct. 24-25.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York; Annual convention, Pinehurst, N. C., Oct. 25-29.

NATIONAL ASSOCIATION OF MANUFACTURERS; Annual meeting, Chattanooga, Tenn., October 25, 26 and 27.

New Publications

Corrugated Culverts—CANTON CULVERT & SILO CO., Canton, Ohio, has issued a small pamphlet describing its riveted Toncan corrugated culverts. Nestable culverts, flat bottom culverts and perforated culverts are illustrated and described in addition to the ordinary drainage type.

Welded Pipe Line—LINDE AIR PRODUCTS CO., New York City, published a booklet entitled "Long Pipe Lines with Arc Welded Joints," which it describes as a record of accomplishments in the oil and gas industries which is in effect a series of illustrations and statements concerning the use of welded lines for the transmission of oil and gas.

Pipe Coating—OHIO VARNISH CO., Cleveland, Ohio, features its pipe coating and equipment for vertical dipping in a new 32-p. catalog. Besides illustrating and describing the methods of application, the catalog tells the story of the company's developing its pipe coating as a result of being called into consultation by two large pipe manufacturers to devise a suitable coating procedure. Metal protective coating, damp proofing, interior and exterior finishes for concrete and wood, metal enamel, laquers, and heat-resisting paints are also briefly considered.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Division of 1926 Highway Surfacing by States

Systems Now Cover 287,928 Miles Of Which 163,059 Miles Are Surfaced

MORE than 13,600 mi. of earth roads included in the State highway systems of the forty-eight States were surfaced by the several highway departments in 1926, according to information compiled from State reports by the Bureau of Public Roads, United States Department of Agriculture.

The total length of surfaced roads constructed by State agencies during the year was 19,492 mi., of which 13,664 mi. was laid over former earth roads and 5,828 mi. represented a rebuilding of old surfaces.

The reports show that the total mileage of surfaced roads in the State highway systems increased by 18,205 mi. during the year; of this increase 4,541 mi. represents no actual work by the States, but consists merely of mileage transferred from county to State jurisdiction, statistical changes resulting from resurveys, etc.

These figures refer to increases in surfaced mileage on the State highway systems only and do not include surfacing laid by the counties or other local governments. They do include, however, all work done with Federal aid.

The accompanying table issued by the Federal bureau shows that the combined State systems embrace 287,928 mi. and that of this, 163,059 mi. is surfaced and 28,456 mi. graded and drained according to engineering standards. The State systems are now about 66 per cent initially improved. The types of surfaced roads existing at the end of 1926 were:

	Miles
Sand clay and topsoil	11,396
Gravel, chert and shale	79,286
Waterbound macadam	18,428
Bituminous macadam	12,927
Sheet asphalt	890
Bituminous concrete	4,815
Cement concrete	31,935
Brick	3,215
Asphalt, wood and stone block	165

MILES OF ROADS IN STATE HIGHWAY SYSTEMS

State	Total Mileage in State Systems	Existing Surfaced Mileage at End of 1926	Mileage of New Surfacing Placed During Year Including Reconstruction
Alabama	3,936.3	2,172.5	467.2
Arizona	2,031.4	1,421.5	75.0
Arkansas	8,346.0	4,153.0	358.0
California	6,582.1	3,537.9	265.4
Colorado	8,966.6	3,499.3	295.3
Connecticut	1,952.1	1,819.3	200.0
Delaware	590.5	590.5	84.8
Florida	5,654.0	2,725.3	349.5
Georgia	6,258.8	2,664.5	327.6
Idaho	4,668.4	2,437.6	269.4
Illinois	9,459.6	4,495.5	361.8
Indiana	4,262.6	4,155.3	376.7
Iowa	6,653.7	3,469.6	498.7
Kansas	7,887.0	1,338.5	403.5
Kentucky	9,646.6	4,192.1	197.6
Louisiana	8,000.0	4,707.2	594.5
Maine	1,574.8	1,306.1	135.1
Maryland	2,419.8	2,419.8	148.1
Massachusetts	1,563.7	1,550.9	102.8
Michigan	6,756.8	6,229.3	354.1
Minnesota	6,930.9	6,353.5	1,412.0
Mississippi	6,721.0	3,839.0	458.6
Missouri	7,640.0	3,375.8	822.7
Montana	7,957.2	926.9	119.2
Nebraska	6,256.0	2,764.1	833.8
Nevada	2,996.0	1,022.6	189.7
New Hampshire	2,256.6	1,963.4	169.4
New Jersey	1,457.8	1,296.9	50.5
New Mexico	9,214.4	1,684.8	73.9
New York	14,068.0	9,853.8	565.6
North Carolina	6,218.0	5,464.0	696.2
North Dakota	6,837.8	1,335.4	539.4
Ohio	11,000.0	9,591.0	2,411.2
Oklahoma	5,589.0	1,584.5	236.1
Oregon	4,468.6	3,220.4	293.6
Pennsylvania	12,033.4	8,439.6	751.3
Rhode Island	821.7	451.5	49.9
South Carolina	5,143.3	3,869.9	584.1
South Dakota	5,923.5	2,467.8	444.8
Tennessee	5,051.0	3,555.5	291.7
Texas	18,728.0	9,256.3	497.1
Utah	3,248.7	1,189.8	150.0
Vermont	4,462.0	3,139.0	139.0
Virginia	5,210.5	3,839.0	165.8
Washington	3,283.6	2,607.3	96.2
West Verginia	3,784.6	1,732.3	494.0
Wisconsin	10,279.6	8,420.4	962.0
Wyoming	3,136.2	929.1	129.4
Total	**287,928.2**	**163,059.3**	**19,492.3**

Steel Pipe Contracts by Sizes for 1926

Steel pipe definitely specified as to quantity and type reported by *Engineering News-Record* in 1926 totaled 4,866,407 lin.ft., of which 639,462 ft. was for riveted or lock-bar pipe. Following is a summary by sizes:

Size in Inches	Steel Riveted or Lock-Bar Lin.Ft.	Steel (Type Unspecified) Lin Ft.
½	.....	30,000
1	.....	33,000
2	.....	27,720
4	.....	79,820
6	17,910	112,390
8	13,158	3,183,760
10	15,373	.....
12	37,658	46,261
14	53,498	17,757
16	28,498	20,407
18	12,658	.....
20	3,623	53,000
22	3,623	53,000
24	38,173	53,000
26	9,223	29,504
30	.....	78,770
32	19,000	550
36	339,210	27,906
42	8,482	30,320
48	2,625	.....
50 to 60	2,430	47,520
Net spec.	34,320	302,260
	639,462	4,226,945
Grand total		4,866,407

Next Week—June Contract Totals, Engineering Construction, Entire U. S.

This Week's Contracts—With Comparisons

Minimum costs observed are: $15,000 for water-works and excavation, drainage, irrigation, levee, river and harbor projects; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, institutional, religious and other buildings.

Week ended	Public Work	Private Work	Total Contracts
July 28, 1927	$20,416,000	$53,778,000	$74,194,000
July 21, 1927	16,847,000	23,895,000	40,742,000
July 29, 1926	16,459,000	35,708,000	52,167,000
Jan. 1 to date			
1927	693,733,000	1,061,826,000	1,755,559,000
1926	630,627,000	1,028,479,000	1,659,106,000

E.N.-R. Index Numbers On July 1, 1927

COST	VOLUME
203.68	297

The Index Numbers are published in detail and with charts in the first issue of each month. The Cost Index is given in full from 1903 through 1926, with a thorough explanation of its method of computation, and a graphic comparison with many other index numbers, in the 48-page pamphlet entitled Engineering News-Record Construction Costs.

Weekly Construction Market

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.80	$4.00	$3.10	$3.35	$3.87½	$3.10	$3.00	$4.00
Structural rivets, 100 lb.	5.00	3.80	4.75	3.50	3.75	4.64	5.00	5.25	5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.24	2.80	2.75	2.30@2.50	2.87½	3.77½	2.95	3.00	3.57
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	54%	51%	48%	41%	42@53.8%	48%	37.83
Cast-iron pipe, 6 in. and over, ton	46.60	40.00	54.00	44.20	46.50	56.50	—44.00	55.00	55.00
Concreting Material									
Cement, without bags, bbl.	2.35	2.40	2.05	2.05	2.22	2.85	2.51	2.65	2.22
Gravel, ¾ in., cu.yd.	1.75	2.20	2.38	2.00	1.65	1.90	1.80	1.25	1.90
Sand, cu.yd.	1.00	1.40	2.00	2.00	1.25	1.00	1.40	1.25	1.35
Crushed stone, ¾ in., cu.yd.	1.85	2.50	2.83	2.00	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	59@61	34.00	56.00	40.50	39.25	34.25	27.00	23.00	55.00
Lime, finishing, hydrated, ton	18.20	24.50	19.00	20.00	25.50	24.00	27.50	24.00	21.00
Lime, common, lump, per bbl.	2.10@3.00	1.35	1.82	1.50	1.70	2.70	1.70	2.80	10.00
Common brick, delivered, 1,000	17@18	12.50	13.60	12.00	13.75	9@10	14.00	14.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0724	.103	.076	.072	.085	....	.10	.10
Hollow partition tile, 4x12x12, per block	.1027	.0724	.103	.076	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	—.84	91½	1.10	.86	—.93	1.08	.92	.98	—1.03
Common Labor									
Common labor, union, hour	.90⅜	.30	.....	.96	....	....	.60	.70	....
Common labor, non-union, hour	....	.25	30@.50	....	30@.60	.31¼@.50	.50	.62½	.30@.35

THE first thirty weeks of 1927 have witnessed the investment of more money in engineering construction than did the corresponding period last year, considering the fact that costs are slightly lower. The cumulative totals for both years are shown in the table at the top of the page.

Firmness with little tendency to change is noted in such materials as, steel pipe; reinforcing bars; lime; hollow tile; slate roofing; 1-in. boards, pine and fir; and North Carolina pine two-by-fours.

Taking the price movement from a nationwide standpoint, there is at present, a definite upward turn in several of the important materials, namely, sand; crushed stone; window glass; wire nails; gypsum plaster; plaster board; zinc oxide; shingles—red cedar, cypress, and slate finished.

Cast-iron pipe showed recent upward price tendencies until the drop which occurred Monday at San Francisco, amounting to $5 per ton, from $49.

Declining trend continues in prices of the following: Common brick; portland cement; yellow pine and Douglas fir two-by-fours; yellow pine flooring, 1-in.; red and white lead; linseed oil; sheathing; and roofing other than slate and wood shingles.

THIS limited price list is published weekly except in the first issue of each month and gives current prices on the principal construction materials in the chief cities. Valuable suggestions on costs of work can be had by noting actual biddings as reported in the Construction News and Unit Prices sections following.

The first issue of each month carries complete quotations for all of the basic materials and for the rest of the important cities, also wage rates for the principal building trades and common labor. The last complete list will be found in the issue of July 7, the next on Aug. 4. Explanation of prices contained in the table will appear from time to time in this section; last shown June 16, 1927, p. 1006.

Finished steel prices appear firmer with materials in better demand than a week or so ago. Improvement has also developed in the non-ferrous metals. Directly opposed to the foregoing is the present condition of pig-iron. Prices in the latter are at the lowest point reached since 1922. Demand is slower for some of the materials used in the metal working shops, such as, cold finished bars, bolts, nuts, and rivets.

Steel reinforcing bars are $1.75@$1.90 per 100 lb., ¾-in. and larger, at Pittsburgh; structural shapes, 3 to 15-in., and plates, ¼-in. thick and heavier, bring $1.75@$1.85 per 100 lb., f.o.b. mill.

Telegraphic reports to E. N.-R. from the Pacific Northwest, announce a steadily increasing lumber output, following the regular seasonal shut-down, which began during the week of July 4. The temporary lull in production passed without causing any perceptible firmness in Douglas fir quotations.

Relative Values of Public Utility Systems

Comparison of Variations in Main Items Making Up Physical Values of Five Classes of Utilities

By C. F. Lambert

Burns & McDonnell Engineering Co.
Kansas City, Mo. Los Angeles, Cal.

THE accompanying charts of classified valuations bring up to date of Jan. 1, 1927, the values of five groups of utilities, as shown in *Engineering News-Record*, issues of May 7, 1925, p. 768, and July 22, 1926, p. 163.

Curve No. 1 shows the relative yearly value of power plant buildings, and separately for labor and material in the proportion in which each enters into the cost of a power plant building or pumping station.

Curve No. 2 and Table I show the yearly value of five- and ten-year averages for water-works systems. These figures are based on twenty-five systems in various parts of the United States, and on sixty-eight separate items going to make up the total.

Curve No. 3 and Table II show the same information for electric light plants. These figures are based on twenty-five systems throughout the United States, and on eighty-four separate items going to make up the total.

Curve No. 4 and Table III show the same information for street railway systems, these figures being based on ten systems and eighty-two separate items.

Curve No. 5 and Table IV, for natural gas systems, are based on eleven systems and fifty-eight separate items.

Curve No. 6 and Table V are for artificial gas systems. These figures are based on twenty-five systems and sixty-three separate items going to make up the total.

Curve No. 7 shows the relative value of the five different utilities.

RELATIVE YEARLY VALUES OF MAIN ITEMS ENTERING INTO PHYSICAL VALUE OF FIVE PUBLIC UTILITIES—1913 = 100

Table I—Waterworks Plant

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
Land	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Buildings	11.2	10.8	11.1	13.3	16.5	18.5	20.6	25.6	20.9	19.0	20.8	20.7	20.6	20.7
Equipment	12.1	12.0	14.0	17.3	22.6	23.4	24.3	26.0	23.4	21.8	22.9	23.0	22.9	22.7
Distribution	72.7	67.1	71.3	94.1	143.2	161.1	165.8	197.8	155.8	130.1	149.8	152.2	143.2	140.5
Misc.	1.1	1.1	1.1	1.4	1.8	2.0	2.3	2.8	2.2	2.0	2.2	2.0	2.1	2.0
Total	100.0	93.9	100.4	129.0	187.0	207.9	215.9	255.1	205.2	175.8	198.6	200.8	191.7	188.8

Table II—Electric Light Plant

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
Land	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Buildings	10.1	9.7	10.0	12.0	14.9	16.7	18.5	23.1	19.9	17.1	18.8	18.6	18.5	18.6
Equipment	38.9	36.7	36.7	47.9	73.5	79.5	81.0	86.7	84.6	75.1	73.4	73.5	73.6	73.0
Distribution	44.8	43.5	47.1	56.1	63.4	69.6	75.2	82.6	77.4	70.4	70.4	69.6	70.9	71.2
Misc.	3.4	3.4	3.4	4.1	5.1	6.0	6.8	8.6	6.8	6.2	6.2	6.1	6.1	6.0
Total	100.0	96.1	100.0	122.9	159.7	174.6	184.3	203.8	190.5	171.6	171.6	170.6	171.9	171.6

Table III—Street Railway System

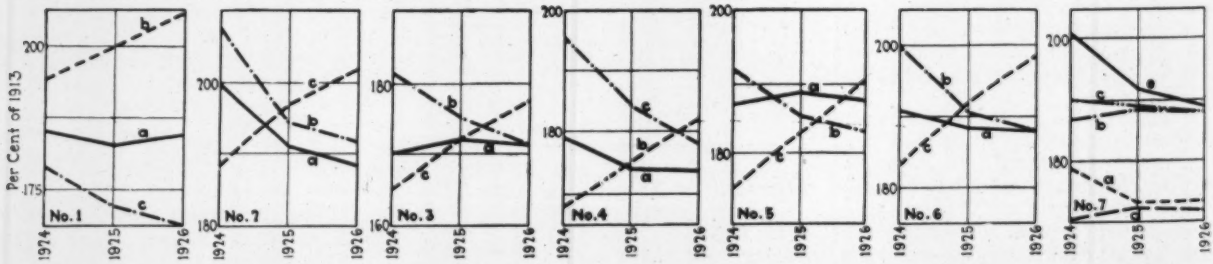
	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
Land	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Buildings	4.7	4.5	4.6	5.6	6.9	7.8	8.6	10.8	8.8	8.0	8.8	8.7	8.6	8.6
Track const.	64.3	63.1	63.4	71.9	83.3	104.8	113.8	144.1	119.9	105.4	113.6	112.8	110.2	110.2
Span const.	5.8	5.4	6.3	8.7	9.9	9.7	10.0	11.1	9.0	8.5	8.7	8.8	8.1	8.0
Cars and equip.	20.9	22.4	22.8	25.1	27.2	31.1	44.4	61.1	59.1	53.0	47.0	42.9	40.7	40.7
Misc.	1.7	1.6	1.6	2.2	2.9	3.2	3.5	4.3	3.6	3.2	3.3	3.2	3.2	3.2
Total	100.0	99.6	101.3	116.1	132.8	159.2	182.9	234.0	203.0	180.7	184.0	179.0	173.4	173.3

Table IV—Natural Gas Plants

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
Land	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Buildings	1.6	1.5	1.6	1.9	2.4	2.6	2.9	3.7	3.0	2.7	2.9	2.9	3.0	3.0
Equipment	1.7	1.6	1.8	2.6	4.0	3.6	3.5	4.1	3.1	3.1	3.1	3.1	3.0	3.0
Distribution	92.2	89.9	92.0	111.0	155.7	182.9	186.5	202.4	187.3	158.4	168.7	173.2	175.0	174.6
Misc.	2.9	2.8	2.9	3.3	4.4	5.1	5.8	7.8	6.4	5.6	5.9	5.7	5.5	5.4
Total	100.0	97.4	99.9	120.4	168.1	195.8	200.3	219.6	201.4	171.4	182.2	186.5	188.1	187.6

Table V—Artificial Gas Systems

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
Land	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Buildings	6.8	6.5	6.7	8.1	10.0	11.2	12.5	15.5	12.7	11.5	12.6	12.5	12.4	12.5
Equipment	30.4	29.1	33.1	49.9	76.4	68.7	67.2	75.9	66.1	62.8	63.4	61.2	60.5	60.6
Distribution	56.5	54.4	55.6	68.0	98.3	114.8	116.5	130.4	115.6	98.2	107.5	108.6	107.3	106.7
Misc.	2.1	2.1	2.1	2.5	3.1	3.6	4.1	5.5	4.6	4.1	4.2	4.0	3.9	3.8
Total	100.0	96.3	101.7	132.7	192.0	202.5	204.5	231.5	203.2	180.8	191.9	190.5	188.3	187.8



No. 1
a. Power plant building cost.
b. Building labor.
c. Building material.

No. 2
a. Waterworks; yearly value.
b. 5-year average.
c. 10-year average.

No. 3
a. Electric-light plants; yearly value
b. 5-year average.
c. 10-year average.

No. 4
a. Street railway systems; yearly value.
b. 5-year average.
c. 10-year average.

No. 5
a. Natural gas systems; yearly value.
b. 5-year average.
c. 10-year average.

No. 6
a. Artificial gas systems; yearly value.
b. 5-year average.
c. 10-year average.

No. 7
Relative yearly value:
a. Street railways.
b. Natural gas.
c. Artificial gas.
d. Electric light.
e. Waterworks.

Assorted Costs Culled from Construction News

$4.27 per Sq.Ft. of floor space is the estimated cost of a store and loft building, 8 stories and basement, 147x201 ft., 26,000 sq.ft. per floor, $1,000,000, at Cincinnati, Ohio. Reinforced concrete and brick, with plain foundation.

Road Contract in Westmount, Ill., has the following unit prices:

Grading	4,400 cu.yd.	$0.80
Concrete paving	7,950 sq.yd.	2.60
Curb and gutter	5,750 lin.ft.	1.25

C.-i. Mains, 24-in., in Boston, $8.93 per lin.ft., total $125,125.

1,000,000-*Gal.* elevated reservoir in Springfield, Ill., 80 ft. diameter by 40-ft. high, on concrete foundation, contract price $59,120; engineer's estimate, $75,000.

Road Bids reported in June in Construction News are as follows per square yard:

Concrete	Westby, Wisc.	$2.47
Bitulithic	Westby, Wisc.	2.99
Vibrolithic	Westby, Wisc.	2.54
Asphalt, sheet	Oakwood, Ohio	4.42
Concrete, 8-in.	East St. Louis, Ill.	4.88
Concrete	Wisconsin	3.06
Vibrolithic, 10-in.	Cleveland, Ohio	6.00
Concrete, 10-in.	Cleveland, Ohio	5.63
Brick, 10-in.	Cleveland, Ohio	6.00
Asphalt, 10-in.	Cleveland, Ohio	7.14
Bitulithic	Keokuk, Iowa	1.61
Concrete, 8-in.	Bergen Co., N. J.	5.83
Concrete, 6-in.	Oakland, Calif.	2.80

Creosoted wood piling $1 to $1.50 per lin.ft. for 1,620 ft. in bridge job in Kansas for the state highway department. There were seven bids, averaging $1.25; the engineer's estimate was $1.05.

Concrete pipe in place for viaduct near Los Angeles, in 16-ft. lengths, either precast or cast in place, $95,000 to $150,000 for 53,456 lin.ft. There were nine bidders, and the average bid was $123,000 or $2.30 per ft.